2008

Evaluating The Impact Of Oocea's Dynamic Message Signs (dms) On Travelers' Experience Using A Pre And Post-deployment Survey

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EVALUATING THE IMPACT OF OOCEA'S DYMANIC MESSAGE SIGNS (DMS) ON TRAVELERS' EXPERIENCE USING A PRE AND POST-DEPLOYMENT SURVEY

by

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B.S.C.E., University of Central Florida, 2006

A thesis submitted in partial fulfillment of the requirements
for the degree of Master of Science
in the Department of Civil and Environmental Engineering
in the College of Engineering and Computer Science
at the University of Central Florida
Orlando, Florida

Summer Term
2008

ABSTRACT

The purpose of this thesis was to evaluate the impact of dynamic message signs (DMS) on the Orlando-Orange County Expressway Authority (OOCEA) toll road network using a Pre and Post-Deployment DMS Survey (henceforth referred to as “pre and post-deployment survey”) analysis. DMS are electronic traffic signs used on roadways to give travelers information about travel times, traffic congestion, accidents, disabled vehicles, AMBER alerts, and special events. The particular DMS referred to in this study are large rectangular signs installed over the travel lanes and these are not the portable trailer mount signs. The OOCEA have been working over the past two years to add several fixed DMS on their toll road network. At the time of the pre-deployment survey, only one DMS was installed on the OOCEA toll road network. At the time of the post-deployment survey, a total of 30 DMS were up and running on the OOCEA toll road network. Since most of the travelers on the OOCEA toll roads are from Orange, Osceola, and Seminole counties, this study was limited to these counties.

This thesis documents the results and comparisons between the pre and post-deployment survey analysis. The instrument used to analyze the travelers’ perception of DMS was a survey that utilized computer aided telephone interviews. The pre-deployment survey was conducted during early November of 2006, and the post-deployment survey was conducted during the month of May, 2008. Questions pertaining to the acknowledgement of DMS on the OOCEA toll roads, satisfaction with travel information provided on the network, formatting of the messages, satisfaction with different types of messages, diversion questions (Revealed and Stated preferences), and classification/socioeconomic questions (such as age, education, most traveled toll road, county of residence, and length of residency) were asked to the respondents. The results of both the pre and post-deployment surveys are discussed in this thesis, but it should be

noted that the more telling results are those of the post-deployment survey. The results of the post-deployment survey show the complete picture of the impact of DMS on travelers' experience on the OOCEA toll road network. The pre-deployment results are included to show an increase or decrease in certain aspects of travel experience with relation to DMS.

The results of the pre-deployment analysis showed that 54.4% of the OOCEA travelers recalled seeing DMS on the network, while a total of 63.93% of the OOCEA travelers recalled seeing DMS during the post-deployment analysis. This showed an increase of almost 10% between the two surveys demonstrating the people are becoming more aware of DMS on the OOCEA toll road network. The respondents commonly agreed that the DMS were helpful for providing information about hazardous conditions, and that the DMS are easy to read. Also, upon further research it was found that between the pre and post-deployment surveys the travelers' satisfaction with special event information provided on DMS and travel time accuracy on DMS increased significantly. With respect to formatting of the DMS, the following methods were preferred by the majority of respondents in both the pre and post-deployment surveys:

- Steady Message as a default DMS message format
- Flashing Message for abnormal traffic information (94% of respondents would like to be notified of abnormal traffic information)
- State road number to show which roadway (for Colonial – SR 50, Semoran – SR 436 and Alafaya – SR 434)
- "I-Drive" is a good abbreviation for International Drive
- If the distance to the international airport is shown on a DMS it thought to be the distance to the airport exit

The results from the binary logit model for "satisfaction with travel information provided on OOCEA toll road network" displayed the significant variables that explained the likelihood of the traveler being satisfied. This satisfaction model was based on respondents who showed a prior knowledge of DMS on OOCEA toll roads. With the use of a pooled model (satisfaction model with a total of 1775 responses – 816 from pre-deployment and 959 from post-deployment), it was shown that there was no statistical change between the pre and post-deployment satisfaction based on variables thought to be theoretically relevant. The results from the comparison between the pre and post-deployment satisfaction models showed that many of the coefficients of the variables showed a significant change. Although some of the variables were statistically insignificant in one of the two survey model results: Either the pre or post-deployment model, it was still shown that every variable was significant in at least one of the two models. The coefficient for the variable corresponding to DMS accuracy showed a significantly lower value in the post-deployment model. The coefficient for the variable "DMS was helpful for providing special event information" showed a significantly higher value in the post-deployment model.

The final post-deployment diversion model was based on a total of 732 responses who answered that they had experienced congestion in the past 6 months. Based on this final post-deployment diversion model, travelers who had stated that their most frequently traveled toll road was either SR 408 or SR 417 were more likely to divert. Also, travelers who stated that they would divert in the case of abnormal travel times displayed on DMS or stated that a DMS influenced their response to congestion showed a higher likelihood of diversion. These two variables were added between the pre and post-deployment surveys. It is also beneficial to note that travelers who stated they would divert in a fictitious congestion situation of at least 30 minutes of delay were more likely to divert. This shows that they do not contradict themselves in their responses to Revealed Preference and Stated Preference diversion situations. Based on a comparison between pre and post-deployment models containing similar variables, commuters were more likely to stay on the toll road everything else being equal to the base case. Also, it was shown that in the post-deployment model the respondents traveling on SR 408 and SR 417 were more likely to divert, but in the pre-deployment model only the respondents traveling on SR 408 were more likely to divert. This is an expected result since during the pre-deployment survey only one DMS was located on SR 408, and during the post-deployment survey there were DMS located on all toll roads. Also, an interesting result to be noted is that in the post-deployment survey, commuters who paid tolls with E-pass were more likely to stay on the toll road than commuters who paid tolls with cash.

The implications for implementation of these results are discussed in this thesis. DMS should be formatted as a flashing message for abnormal traffic situations and the state road number should be used to identify a roadway. DMS messages should pertain to information on roadway hazards when necessary because it was found that travelers find it important to be informed on events that are related to their personal safety. The travel time accuracy on DMS was shown to be significant for traveler information satisfaction because if the travelers observe inaccurate travel times on DMS, they may not trust the validity of future messages. Finally, it is important to meet the travelers' preferences and concerns for DMS.

ACKNOWLEDGEMENTS

I would like to first and foremost state my appreciation to my advisor, Dr. Haitham Al-Deek, who has helped me tremendously with his guidance through the process of my thesis, and research. I would also like to express my appreciation to the rest of the members of my thesis committee Dr. Mohamed Abdel-Aty and Dr. Xiaogang Su for their participation and input.

Secondly, I would like to show my gratitude to Ravi Chandra, John Rogers and Taylor Lochrane for their assistance with my research and friendship. Also, I would like to show my appreciation to the Engineers with the OOCEA for their input; Mr. L.A. Griffin, Mr. Matt D'Angelo, and Mr. Charles Lattimer.

Finally, I would like to show my great appreciation to my family and to all my friends I have made here at UCF for always giving me the support that I needed.

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LIST OF MEDIA/ABBREVIATIONS/NOMENCLATURE/ACRONYMS

1.	ATIS	Advance Traveler Information Systems
2.	AMBER ALERTS	America’s Missing: Broadcasting Emergency Response
3.	CATI	Computer Assisted Telephone Interview
4.	DOT	Department of Transportation
5.	DMS	Dynamic Message Sign(s)
6.	ITS	Intelligent Transportation Systems
7.	LIMDEP/NLOGIT	Econometric software for simulation of binomial discrete choice logit models
8.	OOCEA	Orlando-Orange County Expressway Authority
9.	RP	Revealed Preference
10.	SP	Stated Preference
11.	SAS	Statistical Analysis System
12.	UCF-IRB	University of Central Florida Institutional Review Board

CHAPTER ONE: INTRODUCTION

1.1 Background

Roadway users can face uncertainty of not knowing what their travel time will be from point A to B. Travelers have a good understanding that driving 10 miles on a freeway with no congestion may take them about 10 minutes. The uncertainty comes when there is congestion. Typically, one would expect to experience more congestion during the morning and evening peak hours. The majority of roadway users in urban and suburban areas know that it takes a little more time to get to their destinations during these peak times. The dilemma comes when travelers face unexpected congestion for an unknown period of time due to abnormal conditions such as traffic accidents, disabled vehicles, construction/road work, bad weather, vehicles pulled over by law enforcement, special events, and other causes.

One way to mitigate unexpected delay is to provide accurate and timely traffic information through Dynamic Message Signs (DMS). DMS can display real-time travel information to roadway users.

Figure 1 is an example of the type of DMS studied for this research. These particular DMS are installed over travel lanes, and are not the portable trailer mounted signs that are commonly seen on roadways under construction. These DMS give travelers information about travel times, traffic congestion, crashes, disabled vehicles, AMBER alerts, and special event information.

Figure 1: Dynamic Message Sign

With the knowledge of the current travel time conditions, travelers might be able to make informed decisions that could possibly save them time or save time for other travelers. One could choose to divert from the roadway if he/she is to face a large amount of delay. It is important to note that a traveler can only divert when the capabilities to divert are available. For example, on the freeway, the traveler has access to an exit ramp and has knowledge of alternate routes. When experiencing a large amount of unexpected delay, one could read the travel time from a DMS and tell others who are waiting for him/her that he/she will be delayed by a given amount of time.

DMS is one of the Intelligent Transportation Systems (ITS) technologies whose utilization has increased nationally in recent years. A past report written for the Federal Highway Administration (FHWA) showed that over $330,000,000 was spent by transportation agencies on DMS (1).

OOCEA has added several fixed DMS on their toll road network over the past few years. The default message displayed on these DMS is travel time. Since many of the travelers on the OOCEA toll road network are from Orange, Osceola, and Seminole counties, this study was limited to these three counties. Together these counties had an estimated combined population of 1,694,420 in 2006 (2).

Figure 2 (3) is a map of the toll road network and other major roadways in the greater Orlando area. It is important to note that the OOCEA only has jurisdiction over the purple highlighted roads. These roadways are primarily located within Orange County. The state roadways within the OOCEA toll road network chosen for this study are SR 408, SR 417, SR 429, and SR 528.

Figure 2: Map of OOCEA Toll Road Network

To study the effects of the DMS installed over the past year, a before-and-after study was to be conducted. It is important to note that when the pre-deployment study was conducted there was only one DMS installed on the OOCEA toll road network. The first DMS was located on westbound SR 408 just west of Interstate 4 (I-4). Over the life of this project a total of 35 DMS will be installed over the OOCEA toll road network, 12 signs on SR 408, 10 signs on SR 417, 6 signs on SR 429, and 6 signs on SR 528. It should also be noted that one DMS sign will be installed on SR 520. At the time the final post-deployment survey a total of 30 signs were installed and working on the OOCEA toll road network. The pre-deployment survey ("before" survey) was conducted in November 2006 and the post deployment survey ("after survey") was conducted in May 2008.

This thesis compares the results of the two surveys conducted to show how the OOCEA toll road network users perceived DMS in general. The intention is to show the differences in results for travelers when they have been just introduced to DMS on the toll road network, and when they have increased exposure to DMS on the toll road network. Also, the study will focus on what type of messages toll road users find to be important, and what format and abbreviations toll road users understand. Another point of interest is to use each of the surveys to better understand what encourages travelers to divert off toll roads. One of the main points of interest is to show the percent of commuters who are aware of DMS on the toll road network during both of the study periods to show an increase or decrease in DMS knowledge. To answer these needs, two telephone surveys were conducted asking questions pertaining to DMS to commuters in the Orlando area who were OOCEA toll road network users.

1.2 Research Objectives and Scope

The primary goal of this thesis is to evaluate and compare the results of the "OOCEA DMS Pre and post-deployment surveys." In order to satisfy the OOCEA objectives, it was decided that the tool needed to understand their customers' perception of DMS would be a survey. It was decided that the best method to survey these OOCEA customers would be to use an over the phone survey instead of other methods in order to ensure complete responses to all the questions in the survey. The following is a breakdown of this thesis' objectives.

Analyze "OOCEA DMS Pre and post-deployment survey" results for:

- Knowledge of DMS
- Satisfaction of DMS
- Preferred formatting of DMS
- Statistics of dependency and correlation between different questions and strength of correlation

Binary Choice Logit Modeling for the following variables collected in both the Pre and post-deployment surveys:

- User satisfaction of information given on the OOCEA toll road network
- Revealed Preference (RP) diversion behavior

Comparison of "DMS Pre and post-deployment surveys":

- Z-test of proportions for knowledge of DMS, of other DMS characteristics, and overall satisfaction for significant differences
- Z-test of satisfaction and diversion model coefficients for significant differences
- Comparison of the two best fit models for both surveys for satisfaction and diversion

The survey respondents were only allowed to answer questions in a categorical fashion such as A, B, C, or D. This method was decided upon so there would not be a large variety of responses. Even when describing a respondent's age, the respondents were given ranges to respond categorically. An important aim of this thesis is to show how certain questions were chosen in both the "OOCEA pre-deployment survey," and the "OOCEA post-deployment survey," and how the format was chosen for each of the surveys along with the amount of questions.

The preliminary objective of this thesis is to analyze the "DMS Pre and post-deployment survey" results of the completed 1500 responses. Labeling the mode and second mode for each question is needed in order to understand the various subjects that these survey questions address.

The most important objective of this thesis is to understand and compare the percentage of the customers in each survey that acknowledge DMS on OOCEA toll roads. The subject of DMS is the foundation of this research. A comparison of the percentage of respondents showing knowledge of DMS is a major concern for this thesis. If the respondents of each survey show knowledge of DMS on toll roads, the respondents were asked questions pertaining to their satisfaction on different types of DMS messages and formatting. A comparison of these series of satisfaction responses were important to understand what toll road users desire to see on DMS.

Another objective in this thesis is to evaluate statistically the relationships between multiple question responses for each of the two surveys. The tool used for statistics was the Statistical Analysis System (SAS). To achieve this, one question is compared with another in a contingency table. The responses from the two questions A and B are then determined to be either independent or dependent based on the chi-square statistics. Another objective is to use Cramer's V statistics in order to understand how strong the relationship is between two questions A and B. The Cramer's V statistic is useful when dealing with categorical data. Using Cramer's V will also help in narrowing down what questions to use for the binary logit modeling for each survey results.

Another objective in this thesis was to model the overall satisfaction of traveler information given on the OOCEA toll road network, and RP diversion behavior for each of the two surveys. Binary logit models were constructed using LIMDEP/NLOGIT, and econometrics software for modeling binomial discrete choice models. With binary logit modeling, one can understand what attributes influence an individual traveler's behavior to divert or to stay on the toll road when experiencing congestion. This is also used to profile travelers who are satisfied with travel information on the OOCEA toll road network. For each of the two survey results, separate overall best models will be found and compared, as well as similar models pertaining to similar variables, to show differences between the before-and-after survey results. For modeling and other relationships to be observed, questions that pertain to classifying a respondent such as age, education, and county of residence are asked. It should be noted that in the "post-deployment survey", another classification question was asked pertaining to the length of residency in the Central Florida area.

The final objective of this thesis is to recommend an implementation plan based on the results and conclusions of this research. These comments reiterate on the strong findings within the research in order to understand the effects DMS has on OOCEA toll road users, and to provide improvements, strategies, and suggestions to improve the travels of these customers.

1.3 Organization of Thesis

This thesis is comprised of six chapters in the following organization. Chapter one is the introduction to this study and its purpose is to give the reader a background of the study, the objectives, and scope of this thesis. Chapter two is a literature review of past studies that focused on DMS surveys as a main subject, other transportation related survey studies that used logit modeling, and other transportation related survey studies using before-and-after studies.

Also, this chapter will discuss the contribution of this thesis research for future studies. Chapter three is a section describing the methodology of the analysis. Chapter four gives the results of the pre and post-deployment analysis with a report and comparison of knowledge of DMS, DMS satisfaction, DMS preferred formatting, Revealed and Stated Preference diversion, and SAS statistical values. Chapter five presents a summary of the LIMDEP/NLOGIT results of the user-choice binary logit modeling of the pre and post-deployment analysis for both travel information satisfaction and revealed diversion. This section also presents a comparison between the models for pre and post-deployment for both travel information satisfaction and revealed diversion. Chapter six concludes the overall results of this thesis, provides an implementation plan, and gives recommendations on further research dealing with the subject of DMS.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

The intent of the literature review was to understand similar past transportation studies that dealt with the objectives of DMS perception and modeling driver behavior. The literature review is broken into five different sections. The first section is the introduction. The second section of the review contains past studies that deal with DMS perception surveys with no modeling. The third section of the review examines studies that deal with a variety of transportation studies that model driver behavior. The fourth section of the review examines studies that deal with a before and after study. The fifth and final section of the review deals with the subject of information quality.

The intention of the second section was to investigate the kind of surveys that were conducted when investigating perception of DMS. The types of surveys reviewed ranged from over the phone interviews, web-based questionnaires, mail-in questionnaires, face-to-face interviews, and control group interviews. Other goals of this section were to see what number of completed surveys these studies contained, and what types of questions were in these surveys. This part has a detailed description of the surveys and their results. This research used these surveys to aid in the construction of the pre and post-deployment survey.

The third section deals with driver behavior modeling. These modeling reports dealt with several subjects such as the perception of cost and benefits of DMS, route choice, trip planning, and other issues. Since diverse and extensive human factors are involved in these issues, several forms of inspection used in this section were surveys and infield data collection. A large amount of the modeling reports used questionnaire surveys as a technique to acquire data. A review similar to the previous section was conducted. Other reports in this section used loop detectors to collect data in the field. There was also a variety of model types used. Most of the studies utilized binary-choice logit models, multinomial-choice logit models, and probit models. An important aspect of this section was to investigate the sample sizes used for the models.

The fourth section of this literature review deals with studies that use a before and after study. These studies deal with many aspects of comparing before and after surveys including, modeling and statistical analysis. Many of these studies used Z-tests to compare proportions to show a significant difference. This method could be useful for this thesis. These studies involved a variety of subjects such as red light running, green signal countdown, and mobile speed cameras.

The fifth and final section of this literature review deals with studies involved in the field of information quality. The two studies found on this subject involve the use of route guidance and broadcast traffic information to aide travelers while driving. There were different methods in gaining the data for these studies which included the use of a mailed questionnaire and the use of an interactive route choice simulator to gain certain route guidance data.

2.2 DMS Perception Surveys

Booz-Allen & Hamilton Inc. (4) used the Computer Assisted Telephone Interview (CATI) to survey 2772 commuters in the Boston area to evaluate the performance of SmarTraveler system that offered real-time traffic information via telephones.

Harris and Konheim (5) used a phone to survey peak-hour travelers in the New York metropolitan area (sample size *n*= 1002). This study concluded that 88 % of the travelers want Advance Traveler Information Systems (ATIS) and 78% are willing to pay for these systems.

Travelers are interested in location and duration of delays and alternative route travel times. Radio and DMS are the most highly preferred options compared to the other technology.

Chun-Ming Yang (6) performed a human factors study to enhance communication with motorists through DMS. Message factors such as display effects, color schemes, wording, and formats were investigated. The study was conducted with the use of two methods involving a questionnaire and lab driving simulation with 36 subjects. The questionnaire had forty-four multiple-choice questions displayed in Microsoft PowerPoint format. Study results suggested that static, one-framed messages with more specific wording and no abbreviation were preferred. Amber, green, or a green-amber combination were the most favored colors. Younger subjects took less response time to DMS stimuli with higher accuracy than older subjects. There were no significant gender differences.

Grit Shonfeld et al. (7) investigated the effective design of graphical traffic information. The objectives were to examine the cognitive and the technological aspects of graphical DMS. The survey was conducted as an online questionnaire with 820 respondents at Munich University. The questions focused on topics such as drivers' understanding of abbreviations and symbols, interpretation of color-coded networks, and influence of network orientation to identify motorways. The results of the survey showed that drivers mostly used destination names for their orientation, more than road numbers. A network graph, oriented according to the drivers' position, aggravates the orientation of the driver if only motorway numbers are given. It also showed that unspecific time details are understood by the majority of respondents as the travel time. It is interpreted as delay time only by a small minority. More than one time statement along one route is ambiguous to the driver with respect to the reference points.

University of Arizona (8) used a telephone survey to understand the lasting impact of DMS marketing for 511. This particular study had a total of 411 telephone surveys completed. The questions were related to trip purposes, type of transportation used (i.e., private vehicle, commercial vehicle), and satisfaction of information received. Although these studies focused upon 511, their findings suggested that the lasting impact of DMS marketing for 511 was unclear, short-term impacts appeared dramatic and 511 phone calls peaked when driver was en-route and exposed to DMS.

Texas Department of Transportation (DOT) (9) used an online questionnaire to understand how travelers accessed traffic information (i.e., television, radio, TransGuide website, TransGuide Message signs). There were a total of 690 individuals who responded to the survey. One type of questioned asked was "If you encounter significant traffic congestion due to an incident on the freeway, what do you normally do?" 25% of the respondents answered that they would stay on the freeway and wait it out. Another question asked was, "If you find out about a major incident on your normal route before leaving, what do you normally do?" 86% of the respondents answered that they would take an alternate route. Overall, the results of this survey were reported as basic percentages, and other questions focused on satisfaction.

Lai and Yen (10) focused on how DMS affected driver behavior. A questionnaire was completed by 312 respondents. Behavior such as changing lanes, route changing, and decreasing speed was examined. Information such as traffic reports on alternate routes, weather conditions, and trip cautions were expected on DMS from the respondents. Driving experience, driving purpose, level of route familiarity, level of traffic and weather conditions were conditions that were found to affect a driver's attention to DMS. It was also found that gender, age, and education were significant factors to drivers' comprehension and preference for DMS. Another set of questions was posed to the drivers about their preference of color, and display formats. From the survey results, it was found that drivers preferred red and orange colors compared to green. For cautionary messages, drivers preferred flashing formats for the messages.

Martin and Lahon (11) examined ATIS that is used in Utah. Part of the ATIS technology studied in the report was DMS. The DMS is used in order to give en-route information on incidents, alternate routes, and safety precautions. This was a paper questionnaire where 201 surveys were completed. One of the questions pertained to how frequently drivers responded to weather, safety, or traffic alerts as they were posted on DMS. An open ended question was also asked about how to make DMS more effective. From the responses of this study, it was evident that more destinations could be included on travel time messages, maintenance frequency needed to be increased on message boards to minimize non-functioning units, and travel time messages might include high occupancy vehicle (HOV) lane travel time-savings.

The University of Wisconsin's ITS program conducted an evaluation of DMS reported by Bin Ran, et al. (12). This study investigated the extent of drivers' knowledge regarding general freeway issues, and determining awareness and perception of DMS. A mail questionnaire was used for this survey. 500 questionnaires were sent out to licensed drivers and there was a total response rate of 51.6%. The questions addressed issues such as reliability of travel time and traffic information on DMS. Also, a question pertaining to the knowledge of trip length on alternate routes was asked. It was shown in this study that drivers considered prompt emergency response and reduction of traffic congestion as important needs. In addition, users were willing to change time of trips to avoid or minimize congestion.

Al-Deek et al. (13) used CATI as well as web-based survey to investigate the impact of predictive information on traveler behavior. The sample sizes used for these surveys are 400 and

439 respectively. In general, the respondents indicated that the information that they would need the most is the incident location and expected delay.

2.3 Modeling of Survey Responses & Other Transportation Modeling

Abu-Eisheh and Mannering (14) designed a mail-back questionnaire for the morning commuters of the State College, Pennsylvania metropolitan area to estimate a route and departure time model for peak period travel. They sent the mail-back questionnaires to 505 potential respondents, of which they received 151 usable responses (response rate= 30%). One origin destination pair with three different routes (three choices) was used for the modeling. A multi-nomial logit specification was used to model route choice. The logit model assumes that the utility of a route is a function of the route specific characteristics. The utility of a particular route is a function of the expected travel time on the route and other characteristics like number of traffic signals, queue lengths, etc. Expected travel time as predicted by the Bureau of Public Roads' (BPR) equation was used to avoid problems that would be encountered if actual travel times were used.

Haselkorn et al. (15) conducted a driver survey in Seattle in September 1988. It was analyzed further for information about driver departure time and route choice behavior, particularly about the influence of traffic information (primarily from commercial radio and television traffic announcements and DMS, but also from highway advisory radio and telephone information services) on this behavior. The survey consisted of a 9652 mail-in questionnaire distributed to drivers on I-5 with 3893 responses. Personal interviews of 96 subjects, selected at random from within the groups identified during the analysis of the first set of results, were performed. Questionnaire topics included among others were:

- Daily commute characteristics

- Network familiarity
- Influence of various factors on route choice
- Use of various sources of pre-trip and en route traffic information
- Response to traffic information
- Socio-economic characteristics.

Data was collected on 62 variables. A principal components factor analysis was performed on this data. The components related generally to route choice issues such as commuting distance and time characteristics, attitudes towards different sources of traffic information (radio – based, television, DMS, etc) and commuter characteristics. From these surveys and clustering, a consistent pattern of commuter behavior and traffic information preference was deduced.

The authors concluded the respondents were likely to correctly understand a message when a reason was given followed by a "specific task" (e.g., "Accident at SR 333 interchange, Use SR 333 to divert") rather than a "generic task" (e.g., "Accident at SR 333 interchange, Use alternate route"). They further indicated that travelers would be most likely to change route if the message presented a generic reason and with no mention of any task (e.g., "Accident Ahead").

Uchida and Iida (16) surveyed users of a real-time travel information system in Japan. The system displays the predicted travel times on three routes that connect suburbs of Osaka to the Osaka Downtown using DMS.

The survey was designed to obtain information on two types of driver reaction: short-term tactical choice (the relationship between the displayed message and the drivers' immediate route choice decision), and long-term strategic choice (the gradual change in route choice behavior that results from use of the displayed messages over time.)

Mail-back questionnaires were handed out to drivers at traffic lights downstream of the DMS; those who responded were later sent out additional questionnaires regarding their longer-term reactions to the DMS system. These questionnaires were therefore sent in 6 waves to capture the long-term (strategic) response of drivers. The numbers of responses were 5817 at the end of the six waves. Survey results showed that drivers thought travel time information was sufficiently accurate for their route choice purposes and thus was useful. Roughly 70% of respondents reported diverting at some time; roughly 15% reported that pre-trip or en route information was the reason for diversion. Over time, roughly 40% of respondents reported that they had changed their habitual route as a result of using the ATIS. Multi-nomial probit models of the short term and long term responses were estimated from the survey data. The long-term model provided evidence of a strong inertia effect in the selection of the “routine” route: drivers had a tendency to continue using the same route that they used on prior days, irrespective of age, income or other socio-economic variables. The tactical model showed that the displayed travel time and the habitual route had a significant effect.

Hato et al. (17) used Stated Preference (SP) investigations of drivers’ reactions to DMS messages through mail back questionnaires with a sample size of 6107 and 1907 responses (response rate = 31%). Respondents chose an initial route and were provided with various specific but hypothetical DMS messages. They then responded whether they would switch to the alternative route. The questions investigated the effect of trip purpose, the usual route, traffic conditions on the usual route, expressway tolls, reliability of travel time information provided in DMS messages, the overall trip time, and the length of queues reported in DMS messages with diversion propensity. Ordered probit models were estimated from survey results. The model results showed that route choice was strongly influenced by the information received from the DMS messages. The original route choice had an inertia effect on route choice after information was provided. Drivers on the expressway were reluctant to switch to the parallel route in response to messages although the converse was not true. For daily commute trips where the drivers were under time constraints, the accuracy of the information was proportional to its perceived value.

Emmerink et al. (18) analyzed the joint impact of radio traffic information and DMS on route choice behavior. The empirical analysis was based on a survey held among road users in the Amsterdam corridor in July 1994. 2145 questionnaires were distributed among which 826 were returned (response rate: 38.6%). Several types of discrete choice models (ordered probit, multiple logit and bivariate ordered probit) were estimated to analyze the influence of different factors on route choice. The authors postulated that bivariate models were needed to model the endogeneity of the use of radio traffic information and DMS information. The results find that regular commuters were less likely to be influenced by the information, and the level of satisfaction with alternative routes is strongly related to the type and distance of the alternative road. The analysis also reveals that the impacts of radio traffic information and DMS information on route choice behavior are similar. An important finding in this study was that the results suggested that there was a positive correlation between the use of radio traffic information and DMS information.

Khattak et al. (19) used SP and RP survey (sample size = 586) in the Golden Gate Bridge of San Francisco Bay area in California to investigate traveler behavior under ATIS. The study concluded that travelers might change behavior in response to long delays and information.

Yim and Ygnace (20) used loop detector data to estimate the effects of the messages on DMS on the traffic. The objective of this study was to assess the effects of DMS on individual link flow. The French National DOT conducted traveler surveys in Paris to understand the user requirements of DMS. In May 1992, a mail survey was distributed among Paris area motorists with a sample size of 8000. A telephone survey was conducted thereafter with 100 participants. These surveys focused on gathering information about the ability of motorists to correctly interpret roadside messages. Based on the findings of the motorist surveys, DMS were designed and installed at locations that allowed drivers to make diversion decisions before reaching a congested section of a freeway. Based on the traveler survey results, the French DOT estimated that 50 percent of vehicles would divert given the choice between congested and free flowing links. Given the choice between two congested links, 3 to 5 percent of motorists would divert to the less congested link when comparative information was provided on these links. To evaluate these stated preferences, the authors proposed methods to analyze the loop detector data as a means of revealed preference. The study revealed that the RP diversion behavior was more conservative than the SP of those drivers who responded to the 1992 surveys in the Paris region.

Abdel-Aty et al. (21) conducted a CATI survey to obtain information about the usual and alternative commute routes and their attributes, socio-economic characteristics, and conventional traffic information sources and their influence on behavior. A second CATI survey was conducted to identify any changes in commute characteristics, investigated respondents' perceptions of various attributes of the commute trip, and included the effects of uncertainty on commute route choice decision-making. The total number of surveys conducted was 940, while the number of valid responses received was 564 (response rate = 60%). The third wave mail-back survey showed each respondent optimum (minimum path) commute routes generated by a geographic information system (GIS) and asked about the respondent's knowledge of and preference towards these routes. It also asked SP route choice questions involving information availability from a hypothetical ATIS. Binary logit models were estimated to gauge the effect of the travel time information and uncertainty in travel time information on route choice. The results underscored the significance of traffic information and the potential effect of ATIS on route choice.

Khattak and Khattak (22) investigated en-route diversion under ATIS using a mail-back survey of peak commuters in Chicago (sample size *n*=700) and San Francisco (sample size *n*=3238). The study concluded that en-route diversions are affected by availability and knowledge of alternative routes and amount of delay.

Wardman et al. (23) used an SP approach to undertake a detailed assessment of the effect on drivers' route choice of information provided by DMS. 900 questionnaires were mailed of which 314 responses were received (response rate: 35%). Although drivers' response to DMS information varied according to the availability of viable alternative routes, it was shown that route choice could be strongly influenced by the provision of information about downstream traffic conditions. The findings were that the impact of DMS information depends on: the content of the message (cause of delay and its extent), local circumstances, drivers' characteristics, and previous network knowledge.

The impact of qualitative indicators, visible queues, and delays were examined. Multi-nomial models and nested logit models were estimated to assess the impact of the aforementioned factors. It was found that delay time is more highly valued than normal travel time and that drivers become more sensitive to delay time as it increased.

Bonsall and Palmer (24) surveyed results from previous studies and presented some new results on factors that influence drivers' compliance with DMS messages related to route choice. For effective dissemination of information on DMS, messages should be visible, legible, and understandable. Prior evidence suggested that messages have the greatest effect if they combine routing advice with descriptive information about an incident. It has also been found that advice that gives clear instructions for an immediate action receives higher compliance than more fuzzy advice. An instruction that specifies a nearby problem location is more likely to be followed than one that does not. The effects of providing qualitative information depend strongly on the specific message wording. Other factors that influence the compliance to DMS advisories include general network traffic conditions, and evidence of congestion visible to the driver. There is a natural inertia for drivers to prefer remaining on their current route. The main driver characteristics, which have been observed to influence DMS compliance, are their familiarity with the network and their previous credibility experience of DMS information. Drivers familiar with the network tend to prefer condition information rather than route recommendations. It has been found that for a given DMS guidance message, compliance by familiar drivers is around 10% lower than that by unfamiliar drivers.

Peeta et al. (25) investigated the effect of different message contents on driver response under DMS. This was carried out through an on-site SP user survey. Binary logit models were developed to model diversion choices of drivers. The authors found that the content and detail of relevant information were significant factors affecting drivers' diversion propensity. Socioeconomic characteristics, network spatial knowledge, and reliability of the traffic information displayed are other important factors. Results also indicated differences in the response attitudes of semi-trailer truck drivers compared to other travelers. They provide substantive insights for the design and operation of DMS-based information systems.

Lai and Wong (26) used responses from 475 respondents on the comprehension of messages and message formats on the DMS in Hong Kong. They used the SP questionnaires using hypothetical driving situations and different DMS message formats. Three kinds of message formats were used and they were numerical (travel times), qualitative (traffic condition in words) and switch on lights (congestion level). Logit models were fit to the utility functions defined as a function of the socio-economic characteristics, traffic characteristics, as well as the formats. It was found that the utility for the numerical format was lesser when compared to the other formats, contrary to the expectations. The authors attributed this to unobserved variables and the reason that the qualitative formats are semantically closer to the messages on the radio, thus increasing their utilities.

Abdel-Aty et al. (27) used a CATI survey for the morning commuters in San Jose and Sacramento to estimate commuters' likelihood of using transit under the provision of different types of information. Respondents were asked to rate the top three most important information items that they may need to consider transit as a viable alternative. In addition, they were also asked to rate their likelihood of using transit. An ordered probit model was used to model the natural ordering of the dependent variable. The results indicated that advanced transit information has potential in encouraging the acceptability of transit as a commute mode. The transit information desired by the commuters included frequency of service, number of transfers, seat availability, walking time to the transit stops, and fare information. Socio-economic characteristics like income, education, and trip characteristics including commute time by transit and carpooling were the factors likely to increase the likelihood of acceptance of transit as a commute mode.

Chatterjee et al. (28) conducted a study on the impact of DMS on driver diversion choices using SP questionnaires. 2000 on site questionnaires were distributed, but only 246 responses were received. The questionnaires included questions on the respondent's driver characteristics such as age, sex, annual mileage; details of the journey being undertaken; attitude to unexpected congestion; and attitude to DMS information. It was found that a significant proportion of respondents knew of the DMS and found the information useful. However, not all the respondents who found that information useful diverted. It was also reported that the significant variable that influenced the diversion probability in case of unexpected congestion (estimated through logistic regression models) was the distance to destination. In the case of DMS, the diversion probability was influenced by variables that represented the distance to destination, non-London origin and "severity of the incident" messages on the DMS. Another questionnaire survey was conducted, but it was a RP questionnaire to obtain what the respondents actually did in response to actual DMS messages in the case of real incidents. It was found, however, that the revealed preference responses indicated a more conservative diversion behavior than the SP models.

Zwahlen et al. (29) used mail surveys to evaluate the performance of DMS deployed in Dayton, Ohio in a construction work zone on I-75. The surveys were mailed to around 3177 drivers of which 809 responses were returned. Of these, 660 were analyzed. Survey responses indicated that the motoring public does perceive a certain inaccuracy in the travel times. Almost 97% of surveyed motorists felt that a system providing real-time travel time information, in advance of work zones and in advance of open exit ramps, is either outright helpful or maybe helpful.

Wang et al. (30) studied effect of variable formatting of DMS on the response of car drivers in Taiwan. Driving experience, route familiarity, and traffic crowd also affected drivers' attention to DMS. Age, gender, and education were also significant factors for drivers' preference and response to DMS.

Ulfarsson et al. (31) measured the effect of DMS on mean speeds and speed deviations section on I-90 near Snoqualmie Pass, Washington. The results show that the DMS do significantly reduce mean speed and significantly increase speed deviation. The results also indicate that DMS effectiveness in reducing vehicle speeds may last only in the DMS zone and drivers may engage in compensatory behavior outside the zone.

Henderson (32) investigated the effectiveness of DMS in managing freeway traffic. Factors such as number of DMS installations, location, messages displayed, varied traffic network characteristics, and drivers' response to incident conditions played a function in efficiency of the freeway network. A logit model was used to understand driver diversion and the benefits of DMS. Questions that were asked to a respondent included sex, age, education, regular driver in region, and the trust of the information. These were broken down into binary levels. Questions on diversion behavior were also asked. It was stated in this report that the decision to divert is related to various factors such as severity of the incident, current extent of queue caused by the incident, the driver's experience and familiarity of the network, and incident characteristics delivered via the DMS. The findings in this study showed that female and older drivers were, on average, less willing to divert than males and younger drivers. Also, well-educated individuals were more likely to comply with the DMS messages than their lesser educated counterparts under similar conditions. Incident location was significant in the diversion decision. Truck drivers were more resistant to divert than other drivers. Delay attributed to accidents had the biggest impact on route choice. Visible queues were found to have a significant effect on driver route choice. Those who had never used alternate routes were less likely to be persuaded by the DMS panel advice.

Anirban (33) produced a binary logit model from the responses of 787 persons responding to an online questionnaire. Findings in the literature review of this paper were that historically there was a decreasing tendency for commuters to drive through commercial or industrial area during peak hours. Also, in the literature review of this paper, it was stated that past studies showed that commuters set a threshold of delay and compared this with their perceived travel time and congestion expectation. When frustration or this threshold limit was exceeded, commuters might be inclined to make a route diversion. With the logit model it was found that the significant variables for route choice were gender, age of commuter, home to school average commute time, and the difference between the shortest and longest commute time.

Kim and Chon (34) modeled the en-route diversion behavior with traffic information provided on-site. The factors influencing drivers' route diversion were driver's characteristics, trip characteristics, route attributes, traffic information, and prior experience. The literature review of traffic information summarized that route diversion depends on the reliability of information source, the way information is presented, and the contents of the information. It was also reported that information about accidents, delays and congestion when displayed on DMS, can have a great influence on route choice behavior. The effects of DMS are very dependent upon the phrasing of the message. Another interesting note in this review of literature was that the descriptive information (i.e., information without advice) was likely to have more impact on route choice than prescriptive information, but drivers were more willing to divert in response to a combination of prescriptive and descriptive traffic information than either of the two separately. In this study, 340 questionnaires out of 400 were completed. A logit model was created for this study and found drivers prefer routes with shorter travel times. Though with diversion in mind, as the uncertainty in predicted travel time of a route becomes smaller, the reliability of the information (i.e., DMS) becomes higher, and the propensity for the driver to divert to alternative routes gets stronger. Also, found in this study was the conclusion that with DMS, accident information was the most effective in encouraging drivers to divert. The results of this study show that on-site information had significant influence on drivers' decision to divert to alternative routes.

Peeta and Yu (35) modeled the utility functions for diversion under provision of information as variables with fuzzy components. They coded some of the variables associated with the traffic and network characteristics and the perceptions of these by drivers as fuzzy variables and then proceeded to fit logit models on the utility functions derived from this coding. The performance of the hybrid model was compared with that of a pure multi-nomial logit model. The authors concluded that the hybrid model had better prediction capability, more robustly captured qualitative phenomena, and better explanatory power for qualitative attributes.

Chiu et al. (36) applied a systematic and rigorous statistical approach to investigate relations between DMS message presence and traffic redistribution, and found that DMS signs do cause higher or equal average diversion rates with speed and DMS related to diversion rates.

Peeta and Ramos (37) investigated driver response attitudes to traffic information provided through DMS. They developed DMS driver response models using SP data collected through three different survey administration methods: an on-site survey, a mail-back survey, and an Internet-based survey. In process, they highlighted the strengths and limitations of each method in eliciting driver response attitudes to information provision. The use of different media for the survey administration provided insights for the design of travel surveys. The results illustrated that a combination of survey administration methods may generate more representative data. They also indicate a high correlation between DMS message type and driver response. This suggests message content as a control variable for traffic system operators to trigger optimal routing policies under congested conditions to improve network performance.

Lim and Taylor (38) studied the route diversion under DMS signs in the San Antonio area. They measured the percentage of traffic that diverted to an alternate route when a DMS message was displayed. The sensitivity of the diversion to different factors like familiarity and time constraints, historical or existing traffic conditions, and geographic location were also tested. This study determined that DMS effectiveness was influenced by familiarity and time constraints of the drivers, visibility of the congestion while the DMS message was displayed, an accident with recurring congestion, and a location with a freeway alternate route, which had higher diversion than a site with no alternate freeway route.

2.4 Modeling Before and After Transportation Studies

Foo (39) evaluated the impact of DMS messages on traffic flow using loop detector data by measuring the flow at the transfer locations before and after the message was changed and found that on average a DMS message change can alter the diversion rate by up to 5%, and can shift up to 278 vehicles per hour.

Levinson (40) studied the effectiveness of DMS using loop detector data with incident data to conduct a before-and-after study which attempts to quantify the network-wide travel time benefit of DMS systems. The effectiveness was measured using a discrete choice model to estimate the response of drivers to messages provided by DMS, and a statistical analysis on the variation of diversion rate with and without DMS. A weighted probit model was used to estimate the drivers' diversion behavior given the characteristics of messages and the nature and location of the incident. Factors considered in this study were: availability of an alternate route, nature of the incident (i.e., congestion, crash, stalled vehicles, or roadwork), peak period or non-peak period, whether the message attracts vehicle to exit ramp, discourage vehicles from diverting, or has no influence on the route. The model showed that the probability of diversion increased in response to the message of the incident and congestion. With the statistical analysis, DMS was shown as an effective tool in route guidance that could increase drivers' diversion rate significantly. The study also concluded that DMS was more effective in light traffic than in heavy traffic. This may have been due to the fact that it is difficult to change lanes, merge or divert in heavy traffic. Also stated, drivers prefer to start to divert at several exits prior to an incident. The before-after part of the study results showed that DMS has no obvious effects on the reduction of travel time. However, DMS along with ramp meters was shown to reduce travel times.

Lum and Halim (41) studied the effects of a green signal countdown device with the use of a before-and-after study. The methodology focused on the use of a before-and-after study which compared certain red-stopping and red-running characteristics obtained before the green signal countdown device was installed and at intervals of 1.5-months, 4.5 months, and 7.5 months after the devices had been installed. Test statistics were calculated for both red-light running and red-light stopping before and after the green signal countdown devices were installed at the study intersection. With respect to red-light running, the test statistic was shown to be significant at a 95% confidence level after 7.5 months for only 1 day in each of the studied lanes at the given intersection. With respect to red-light stopping, the test statistic was shown to be significant at a 95% confidence level after 7.5 months for every day in both of the studied lanes at the given intersection. This method of significance testing will be a useful tool in the comparison of the before-and-after studies of this thesis. The study showed that, in the long run, the green signal countdown devices helped to increase red-light stopping, but had minimal effect on red-light running.

Lum and Wong (42) used a before-and-after study to evaluate the impacts of installing and operating red-light cameras on driver stopping propensity upon the onset of amber. Logistic modeling was used by the researchers to model the decision making of the drivers at each of three individual intersections (2 “T”-intersections and 1 “X”-intersection) before-and-after the installation of red-light cameras. Also, to add a control to the experiment, a non-camera approach was also modeled using a logistic regression model. The modeling results suggest that at the “X”-intersection the red-light camera basically increased stopping propensity in general as well as with respect to lane choice. The modeling results suggest that at the “T”-intersection the red-light camera increased the stopping propensity with respect to the distance from the intersection. Lastly, there was no significant impact upon the stopping propensity along non-camera approaches. This shows that the motorists had some sort of knowledge of the scope of surveillance of the red-light cameras.

Elvik (43) shows, by means of examples taken from other studies, how the approach taken to controlling for confounding factors in before-and-after studies can profoundly affect the results of road safety studies. The author includes some road safety studies to support the point which is that readers of observational before-and-after studies of road safety measures should always pay very careful attention to what these studies say with regards to the control of confounding factors.

Christie et al. (44) used a controlled before and after study comparing two methods for examining the local effectiveness of mobile speed cameras. The two methods used in this analysis were using circular zones surrounding the cameras to gather data, and using a route based method to gather data. Using the circular based method, circles of radius 100, 300, 500, and 1000 meters were drawn around each camera site. Using the route based method; routes were extended in both directions to the set distance of 100, 300, 500, and 1000 meters. The results of this analysis showed that camera sites had a lower than expected number of injurious crashes up to 300 meters using the circular based method and up to 500 meters using the route based method. Thus, the route based method was shown to be a better method of effectiveness at distances up to 500 meters showing a 51% reduction in injurious crashes.

Jensen (45) conducted a before-after crash, injury and traffic study of constructing bicycle tracks and marking bicycle lanes. For this study, a stepwise methodology was used, where a general comparison group was used to account for crash trends, changes in traffic volumes were taken into account, and an analysis of long-term crash trends was made to check for abnormally high or low crash counts. For this study, only roads where bicycle facilities had been applied and no other scheme had been implemented in the before and after periods and in the years when the bicycle facility was applied. The results of this before and after study showed that the best estimate for safety effects of bicycle lanes in urban areas were an increase of 5 percent in crashes and 15 percent in injuries. Bicyclists’ safety had significantly worsened on the roads where bicycle lanes had been marked.

The city of Madison Department of Transportation (46) tested a regulatory in-street "Yield to Pedestrians" sign at selected marked crosswalk locations. There were three original test sites with two new sites added in 1999. A before-and-after study was conducted at both of the new sites and an after study was conducted at two of the original sites. The after study data at the two original sites were compared to the year before data to evaluate longer term impacts of the signs. The measure of effectiveness of this study was the occurrence of motorists to yield to pedestrians who were using the crosswalks. To test if the changes between the before and after periods were statistically significant, a Z-test for proportions was used. The data collected showed that the effectiveness of the sign differed somewhat at each test site, but overall the data demonstrated the "Yield to Pedestrians" sign had potential to substantially increase the percentage of motorists yielding to pedestrians at crosswalks adjacent to the sign.

2.5 Information Quality

Bonsall (47) reviewed empirical evidence on the influence of route guidance advice on route choice, showing that users were reluctant to follow advice unless it was found convincing, and less familiar to the person. This suggested that the more familiar the driver was with the route, the less likely he/she was to accept the advice. One study discussed in this paper involved the use of an interactive route choice simulator ("IGOR") to collect necessary route guidance data. The studies brought forth in this paper showed that route choice will be influenced by in-vehicle route guidance and information (IVRGI) only if the information or guidance was credible, relevant, and clear. The credibility depended on how up to date the information was, how detailed a network it was based on, and on the existence of corroborating and conflicting evidence on the ground. Relevance and clarity depended on the extent to which the information provided was targeted to the particular needs of the driver at the time, with the most appropriate presentation.

Khattak et al. (48) used a mail-back questionnaire to gain traffic information from automobile drivers who made repeated trips during which broadcast traffic information was available to them. These drivers were of interest because it would be easier for the respondents and the researchers to identify behavioral patterns, and because these drivers are presumed to experience the worst traffic congestion on a regular basis. The researchers modeled these responses to experienced delay by the decision to stay on the usual route, or to divert to an alternate route. The key finding in this study was that real-time traffic information influences en route diversion behavior. Drivers showed a greater inclination to divert if the delay information was provided to them through radio reports, then if they observed the delay.

2.6 Conclusions from Literature Survey

From the literature review, it was evident that the acceptance of DMS was associated with the travelers' perception and their subjective attitudes towards information and its presentation. Most of the studies have found that demographic and socio-economic characteristics were important factors in assessing the satisfaction of the travelers towards a novel traveler information technology like the DMS. However, travelers also have specific preferences about the formats and contents of messages and information posted on the DMS. While most of the studies show that the travelers adopt DMS for their traveler information needs, DMS do not necessarily change their travel behavior. Network familiarity, proactive information, and advisory information had been found to have different effects at different locations of the study. Also, it was concluded from the literature review that responses to SP and RP are not in agreement all the time. Generally, RP diversion rates were more conservative than

SP. They are highly correlated. Also, multinomial and binomial logit models have been predominantly used to model the diversion behavior under traveler information scenarios with DMS. The effect of DMS has been found to vary in different study sites. Another conclusion from this literature review was that when comparing before-and-after studies, z-test statistics can be used as a method of showing significant differences. When comparing the before-and-after surveys of this particular thesis, this method will be used to compare and show significant differences between the two surveys.

The research done for this thesis will be beneficial for further research in many ways. The research done for this thesis focuses mainly on the idea of DMS on toll roads. This differs from much of the literature found on the subject of DMS. Also, this research deals with the idea of modeling satisfaction with respect to many aspects of DMS. Much of the research found did not deal with this specific issue. The literature surveyed so far showed a majority of the studies that were predominantly directed at the descriptive aspect of the DMS information. A few of the studies analyzed the effect of DMS using simulations. A comprehensive modeling towards both satisfaction with DMS as well as diversion based on DMS messages on the toll roads has not been attempted. Moreover, this is a unique study where a before-and-after study was attempted to compare the effect of extensive DMS deployment on the toll roads. It is therefore expected that this effort sheds new light on the driver behavior on the toll roads, in the presence of information.

CHAPTER THREE: METHODOLOGY

3.1 Design and Implementation of the Survey Instrument

The methodology was to conduct a before-and-after survey to gather the opinions of the toll road travelers on the DMS and analyze and compare the responses from each survey. It was decided that the survey would be conducted in two stages, a pre-deployment survey conducted in the Fall of 2006, and a post-deployment survey conducted in the Spring of 2008.

The developed methodology consisted of the following steps:

3.1.1 Identify the OOCEA Network and the Implementation Plan of the DMS

During the pre-deployment survey in the Fall of 2006, there was only one DMS sign installed on westbound SR 408 between I-4 and Orange Blossom Trail. Additional DMS were continuously added on SR 408, SR 417, SR 429, and SR 528 throughout the time period between the pre and post-deployment surveys, and a total of 30 DMS were installed and running at the time of the post-deployment survey. On the following page, Figure 3 shows the map of the OOCEA network with the implementation plan of the DMS (49) on various toll roads in the network. Of particular emphasis were the traveler expectations of traffic information from DMS, and the attitude of travelers towards the DMS currently installed on the OOCEA toll road network. The responses from the pre-deployment survey were used as a basis and compared with the responses of the post-deployment survey to show how travelers' responses have changed with an increased number of DMS installed on the OOCEA toll road network. A sufficiently large sample size was deemed necessary for the before-and-after studies to obtain statistically significant results that can capture the representative sample of travelers commuting on the OOCEA toll facilities.

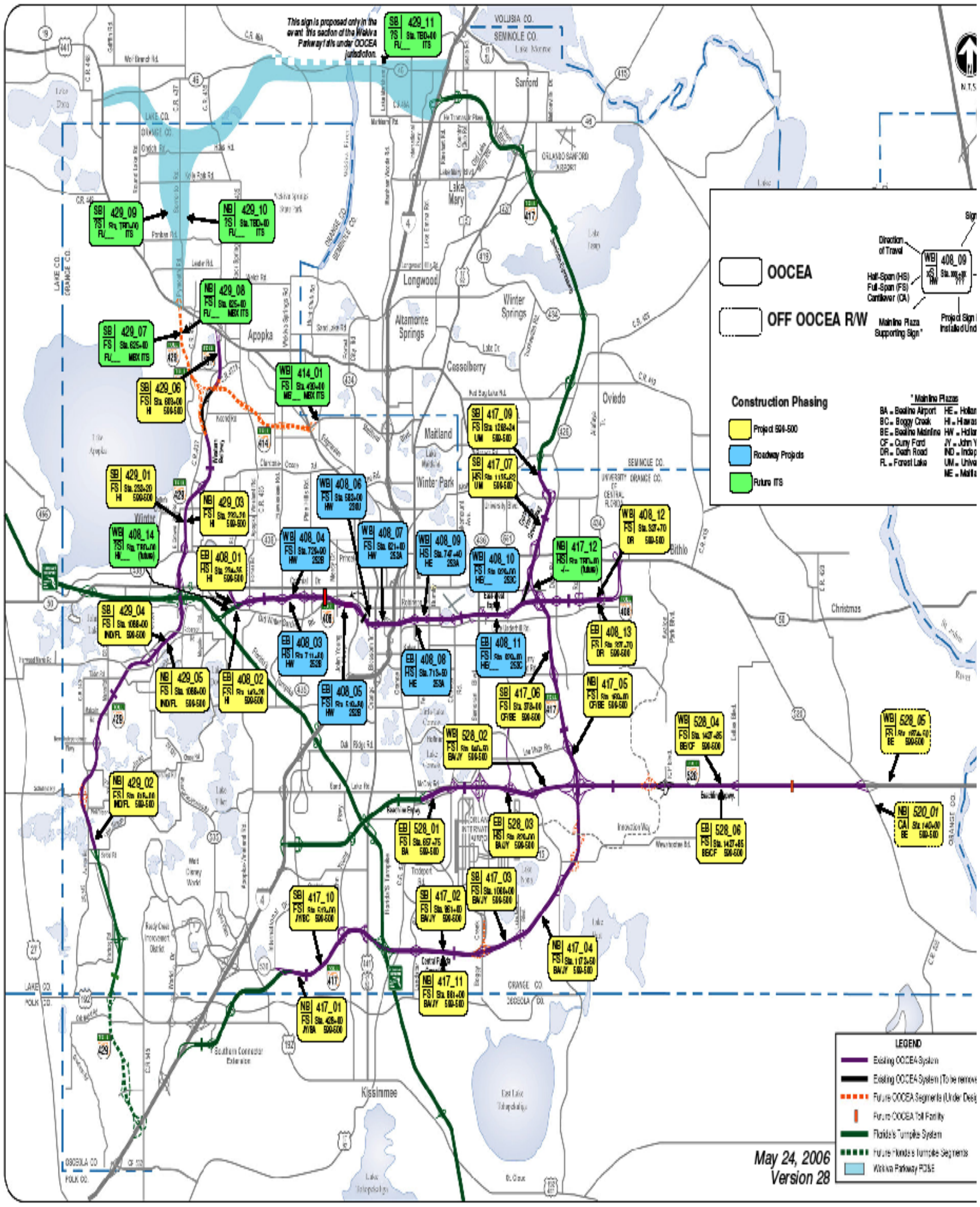

Figure 3: Implementation Plan for DMS Installation on the OOCEA Network (source: OOCEA (49))

3.1.2 Survey Instrument Design

The pre and post-deployment surveys were aimed at travelers in the Central Florida region who use the OOCEA toll system. Since OOCEA operates toll roads in Orange County, most of the travelers on the toll roads have their origins and destinations in and around Orange County. It was decided that the survey instrument would be directed towards toll road users from Orange, Seminole, and Osceola Counties due to the majority of OOCEA toll road users reside and work in these counties.

A telephone survey was considered appropriate based on the scope and time constraints of the research. The other alternatives were mail questionnaires or internet surveys, which were shown to have a very low response rate from literature surveyed. The Computer Assisted Telephone Interview (CATI) has been known for its success and effectiveness.

Each survey needed to incorporate questions pertaining to:

a. Demographic characteristics of the respondents: These characteristics which included age, education and location characteristics enable analysis of the different perception of the commuters belonging to different demographic and socio-economic groups.
b. Trip characteristics of the respondents: These characteristics included the toll road used, the trip purpose, the number of weekly trips, familiarity of the traveler with the network and other characteristics for the most frequent trips undertaken on the toll road network.
c. Source for acquiring traffic information on toll roads: These questions were needed to know whether the travelers were aware of DMS on the toll roads and if they used them to actively acquire real-time traffic information.

d. Perception of benefits and satisfaction from the information on DMS: This set of questions was needed to assess the perception of the travelers towards the information presented on the DMS and if they appreciate this information.
e. Formats and interpretation of information presented on the DMS: This set of questions was needed to know the preferences of the travelers with respect to the formats of the contents presented on the DMS.
f. RP and SP towards diversion: This set of questions was needed to analyze the behavior of the commuters under unexpected congestion scenarios in the presence of information. The aim of these questions were to know if the DMS made it easier for the commuters to either continue on, or divert from, the toll roads.

The original draft questionnaire for both the pre-deployment survey and post-deployment survey were tailored to the objectives of this study. However, it was also essential to make sure that the questions would not be deemed invasive by the respondents. The number of questions asked to the respondents needed to be kept under a reasonable limit, so as to not have the respondent abort the questionnaire and to solicit honest responses. Also, depending on the characteristics and responses from the respondent, multiple branches of questions emerged in the preliminary survey draft. Each draft was revised multiple times. Furthermore, the researchers secured approval from the UCF Institutional Review Board (IRB). Appendix A contains the IRB approval pages for both pre-deployment survey versions 14 and 14A, and for post-deployment survey version 15. The final survey version for both deployment surveys included questions pertaining to the characteristics described above. Table 1 shows a concise description of the questions asked in the pre-deployment survey. Table 2 shows a concise description of the questions asked in the post-deployment survey. The Appendix B includes both complete pre-deployment surveys along with the complete post-deployment survey. The pre-deployment survey contained a total of 32 questions on the whole. However, depending on the branches in the survey, the respondent would have to answer a lesser number of questions. The post-deployment survey contained a total of 41 questions on the whole. However, similar to the pre-deployment survey, depending on the branches in the survey, the respondent would have to answer a lesser number of questions. Each survey included two filtering questions that excluded any respondents below 18 years and those who had not used OOCEA toll roads in their recent past. It was decided for the pre-deployment survey to collect 1000 completed responses, but another 500 responses were collected (albeit using a slightly different version of the survey) increasing the total number of completed responses to 1500. It was decided that the same 1500 number of responses were to be collected for the post-deployment survey.

Table 1: Description of Questions Asked as Part of the Final Pre-Deployment Survey Design

Question Number	Question	# of choices	Category
-	Are you above 18 years	2	Filtering
Q1	Have you traveled on OOCEA toll roads in the past 6 months	2	Filtering
Q2	Frequently traveled toll road	4	Trip
Q3	Number of one-way trips per week	4	Trip
Q4	Trip purpose	5	Trip
Q5	Alternate routes known	5	Trip / familiarity
Q6	Pay tolls	2	Trip
Q7	Type of vehicle used for trips	4	Trip
Q8	Acquisition of traffic information while on toll road	5	Source for acquisition
Q9	Satisfied with traveler information on toll roads	4	Satisfaction
Q10	Recall seeing DMS on toll roads	2	Source for acquisition
Q11	Are DMS helpful in improving traveling experience	4	Satisfaction
Q12	Are DMS helpful in providing hazard warnings	4	Satisfaction
Q13	Are DMS helpful in giving special event information	4	Satisfaction
Q14	Are DMS easy to read while driving	4	Satisfaction
Q15	Do DMS display accurate travel time information	4	Satisfaction
Q16	Steady / Alternating messages on DMS	2	Format
Q17	Flashing / All Flashing / Non Flashing messages on DMS	3	Format
Q18	Encounter congestion in the past 6 months	2	Diversion behavior
Q19	Cause of unexpected congestion	6	Diversion behavior
Q20	First source of unexpected congestion	5	Diversion behavior
Q21	Response to unexpected congestion	4	Diversion behavior
Q22	SP to diversion	4	Diversion behavior
Q23	Additional travel added to the congestion	4	Diversion behavior
Q24	Reason to continue on the toll road	5	Diversion behavior
Q25	How did DMS help reschedule travel	5	Satisfaction
Q26	Do DMS help save time	4	Satisfaction
Q27	Is I-Drive a good abbreviation for International Drive	4	Format
Q28	Preference to identifying a roadway	2	Format
Q29	Interpretation of travel time to airport	2	Format
Q30	Age	5	Demographic
Q31	Education	5	Demographic
Q32	Zip code	input	Demographic

Table 2: Description of Questions Asked as Part of the Final Post-Deployment Survey Design

Question Number	Question	# of choices	Category
-	Are you above 18 years	2	Filtering
Q1	Have you traveled on OOCEA toll roads in the past 6 months	2	Filtering
Q2	Frequently traveled toll road	4	Trip
Q3	Number of one-way trips per week	4	Trip
Q4	Trip purpose	5	Trip
Q5	Travel Time on the most traveled Toll way	5	Trip
Q6	Alternate routes known	5	Trip / familiarity
Q7	Travel Time on the alternate route	5	Trip
Q8	Pay tolls	2	Trip
Q9	Type of vehicle used for trips	3	Trip
Q10	Acquisition of traffic information while on toll road	5	Source for acquisition
Q11	Satisfied with traveler information on toll roads	4	Satisfaction
Q12	Recall seeing DMS on toll roads	2	Source for acquisition
Q13	Are DMS helpful in improving traveling experience	4	Satisfaction
Q14	Are DMS helpful in providing hazard warnings	4	Satisfaction
Q15	Are DMS helpful in giving special event information	4	Satisfaction
Q16	Are DMS easy to read while driving	4	Satisfaction
Q17	Do DMS display accurate travel time information	4	Satisfaction
Q18	Abnormal travel times displayed on the DMS	2	Abnormal travel times
Q19	Divert due to abnormal travel times	2	Abnormal travel times
Q20	Reason for not diverting off the toll road	4	Abnormal travel times
Q21	Encounter congestion in the past 6 months	2	Diversion behavior
Q22	Cause of unexpected congestion	6	Diversion behavior
Q23A/Q23B	First source of unexpected congestion	5	Diversion behavior
Q24	Location (Toll Road) where the congestion was experienced	4	Diversion behavior
Q25A/Q25B	Direction on the toll road when the congestion was experienced	2	Diversion behavior
Q26	Additional trip time added due to congestion	4	Diversion behavior
Q27	Time period of travel during the congestion experience	3	Diversion behavior
Q28	Response to unexpected congestion	4	Diversion behavior
Q29	Did the DMS influence your response to congestion	2	Diversion behavior
Q30	reason to continue on the toll road	5	Diversion behavior
Q31	Stated preference to congestion	4	Diversion behavior
Q32	How did DMS help reschedule travel	5	Satisfaction
Q33	Do DMS help save time	4	Satisfaction
Q34	SR436 vs Semoran	4	Format
Q35	SR426 Vs Aloma	2	Format
Q36	SR434 Vs Alafaya	2	Format
Q37	Should DMS inform you of abnormal conditions like accident?	2	Format
Q38	How should the DMS inform you of this abnormal situation?	4	format
Q39	Age	5	Demographic
Q40	Education	5	Demographic
Q41	How long have you resided in Central Florida	6	Demographic

3.1.3 Survey Instrument Implementation

The pre-deployment survey was conducted from the 1st of November, 2006 to the 10th of November, 2006 to gather 1000 combined responses from the Central Florida Orange, Seminole, and Osceola counties by adopting CATI. The survey selection was totally random. Thousands of travelers residing in these three Central Florida counties were interviewed on the telephone. This technique was proven efficient through national studies. In about two weeks, the desired sample size of 1000 responses was reached.

For the first 1000 completed pre-deployment survey version (Version 14), Q18 was asked to all the respondents to see if they had experienced any unexpected congestion within the last six months on the toll roads. If the travelers responded that they had, these respondents were asked the RP diversion Q21. If the travelers responded that they had not experienced any congestion, these respondents were asked SP diversion Q22. The respondents that were asked Q21 were not asked Q22. If the respondents in the RP diversion Q21, and SP diversion Q22 answered "A – Stay on the toll road and wait it out," they were then filtered to Q23 (What amount of unexpected congestion would cause you to divert off your route?).

The issue with the first pre-deployment version (Version 14) of the survey was the travelers who were asked the RP diversion Q21 were not asked the SP diversion Q22. It was thought that it was important to have both questions answered to aid in the RP diversion modeling. In addition, Q23 was changed so that it can be used in the RP diversion model.

The second pre-deployment survey version (Version 14A) varies by the following: Those who answered RP diversion Q21 were also asked SP diversion Q22, and Q23 was changed to new Q23A in order to ask Q21 respondents about the unexpected congestion, how much time did you expect it to add to your trip?

These changes prompted the collection of 500 additional responses, albeit using pre-deployment survey Version 14A. This additional sample was collected in another week. The two surveys of combined 1500 responses were completed as scheduled.

The post-deployment survey was conducted from the 1st of May, 2008 to the 22nd of May, 2008 to gather 1500 responses from the Central Florida Orange, Seminole, and Osceola counties by adopting CATI. The post-deployment survey went through an additional 15 versions based on multiple changes that were made between the pre and post-deployment surveys. Some of the questions asked during the pre-deployment survey were eliminated and some new questions were added in the post-deployment survey based on approval from OOCEA.

The questions eliminated from the pre-deployment survey were questions 16, 17, 27, 28, and 29. These questions dealt with the idea of formatting on the DMS, and were eliminated on the basis of not asking the same formatting questions in both survey versions. New formatting questions 34, 35, 36, 37, and 38 were added in the post-deployment survey. Also, post-deployment survey questions 5 and 7 were added to gain better knowledge of the traveler's expected travel time on the toll roads and on their best known alternate route. Also, upon request from OOCEA, post-deployment survey questions 18, 19, and 20 were added to address the subject of abnormal travel times displayed on the DMS. Furthermore, post-deployment survey questions 24, 25A, 25B, and 27 were added to gain knowledge of where and when these travelers were experiencing congestion on the OOCEA toll road network. Finally, post-deployment questions 23A, 23B, and 29 were added to inquire if a DMS had either informed a traveler of unexpected congestion, or was the reason someone either diverted or stayed on the toll road. Post-deployment survey question 23 was altered from pre-deployment survey version question 20 to have two versions, 23A and 23B. Question 23A was asked only if the traveler had knowledge of DMS, and question 23B was asked only if the traveler did not have knowledge of DMS. This was done so there would be no conflicting results, for example someone with no prior knowledge of DMS stating they gained information from DMS.

Both the pre-deployment survey and post-deployment survey were conducted on both weekdays and weekends to complete the study as soon as possible and also to capture customers who like to respond during certain periods of the week as their preferences were different.

Both versions of the pre-deployment survey, versions 14 and 14A, along with post-deployment survey version 15 are located in Appendix B. The results of the 1500 completed pre-deployment survey responses are located in Appendix C, and the results of the 1500 completed post-deployment survey responses are located in Appendix D.

3.2 Descriptive Analysis and Modeling

3.2.1 Descriptive Analysis of Response from the Survey

The responses from each of the two surveys were then analyzed and certain relevant descriptive statistics were reported. These statistics included the distribution of DMS knowledge responses based on demographic and trip characteristics, the satisfaction with DMS questions, the DMS formatting questions and the RP and SP response to diversion questions. The mode (most frequent response) was reported question by question, and certain responses were analyzed for different groups (i.e. response to formatting questions with Age groups, etc.). Cross tabulations were performed and chi-square tests were conducted to check for the dependence between characteristics of the respondents and their preferences towards various aspects of travel information.

3.2.2 Modeling Satisfaction and Diversion

The responses from each survey were used to set up binary logit models that estimate the satisfaction of the toll road users with the traffic information available on toll roads, and their revealed diversion preferences. Once these logit models have been found, a comparison between the models of pre and post-deployment can be conducted to show differences between the two modeling results. The predictor variables used in these models are predominantly categorical. They capture the demographic and trip characteristics of the travelers. In addition, the models for satisfaction capture the different aspects of information presented on DMS and the satisfaction of the travelers with the same attributes. The RP diversion models capture the exposure of the commuters to DMS, and their actions to real-world congestion and delays.

An in depth explanation of models for pre and post-deployment will be presented in Chapter 5. An example of how the data was set up for modeling in located in Appendix E, and samples of the LIMDEP/NLOGIT model outputs are located in Appendix F.

3.2.3 Conclusions

The results and comparisons of the descriptive analysis and modeling are used to show a difference in behavior and attitude of the travelers towards DMS. These results serve as a basis for an implementation plan for OOCEA that can be utilized in improving the DMS.

CHAPTER FOUR: RESULTS OF THE PRE AND POST-DEPLOYMENT ANALYSIS

4.1 Descriptive Statistics

Many of the variables collected as part of the pre and post-deployment surveys are qualitative and categorical in nature. Therefore, for most of these variables, there is no inherent order, except for demographic variables such as age group, education level, and most traveled OOCEA toll road. In some circumstances, it is useful to view different levels of satisfaction on an ordinal scale. For example “most frequently used toll road” has four categories/levels: SR 408, SR 417, SR 429, and SR 528. These categories do not have an increasing or decreasing order. Inversely, age has five categories/levels: 18-25, 26-35, 36-50, 51-65, and Over 65. These categories can be represented in an increasing/decreasing order depending on the context. With different levels of satisfaction or agreement, “Strongly Agree”, “Agree”, “Disagree”, and “Strongly Disagree”, it is sometimes beneficial to look at them as just different labels for agreement or to assign them an increasing order of agreement or disagreement. It is essential to know the distinction between ordinal and categorical variables as descriptive statistics should have different meanings depending on whether a variable is interpreted as categorical or ordinal.

For categorical variables with no inherent order (also referred to as nominal variables), the mode is an important measure of central tendency. The mode refers to the observation or value that appears most frequently in a sample. In the case of continuous numerical variables, a mode is of limited importance when compared to mean and median. Therefore, the mode will be reported for the qualitative variables collected from the responses in the survey, while the mean (average) will be reported for the ordinal variables in the survey. The mode is an important statistic as it describes the most frequent response from the respondents of the survey. It can indicate an overwhelming preference of the commuters with respect to the relevant question. Further discussion of the mode for various questions from the survey is provided in the results section.

The results of the pre-deployment survey come from the combined 1500 responses from the two pre-deployment survey versions 14 and 14A, and the results of the post-deployment survey are the 1500 respondents from post-deployment survey version 15 unless noted otherwise.

4.2 Awareness of DMS on OOCEA Toll Roads

One of the main objectives of each of the two surveys is to know the percentage of travelers that have knowledge of the presence of DMS. It should be noted that both the pre and post-deployment survey results are presented, but the most important result is the post-deployment results. The pre-deployment results are presented to show an increase percent of knowledge with increased deployment. Pre-deployment survey question 10 and post-deployment survey question 12 were used to measure what percentage of travelers had knowledge of the presence of DMS. In each survey, before this DMS Knowledge question was asked to the respondent, it was clearly defined what the DMS were, and for the purpose of the questionnaire, the DMS referred to were specified as being the large overhead signs only used on the OOCEA toll road network. The DMS Knowledge question is shown in Figure 4.

10) A Dynamic Message Sign is an electronic traffic sign used on roadways to give travelers information about travel times, traffic congestion, accidents, disabled vehicles, AMBER ALERTS, or special events. The particular dynamic message signs referred to in this survey are large rectangular signs installed over the travel lanes. These are not the orange, portable trailer mounted signs you see on the side of the road during construction. For the purpose of this survey, please limit your comments to dynamic message signs on Central Florida toll roads only, not those found on local roads or interstate highways.

Do you recall seeing a Dynamic Message Sign during your travel on State Road 408 (East-West Expressway), State Road 417 (GreeneWay), State Road 429 (Western Expressway), State Road 528 (Beach Line)?

a) Yes

b) No

Figure 4: DMS Knowledge Question

From the results of the pre-deployment DMS Knowledge Question, 54.4% (816/1500) of the people surveyed recalled seeing DMS on the OOCEA toll roads. Then from the results of the post-deployment DMS Knowledge Question, 63.93% (959/1500) of the people surveyed recalled seeing DMS on the OOCEA toll roads. This shows an almost 10% increase in DMS knowledge from the pre-deployment survey to the post-deployment survey. The overall significance of this increase will be further investigated later in the section of the report.

The percent knowledge of DMS was also explored by grouping the responses by the following demographic variables:

- Age Group
- Education Level
- Most Traveled OOCEA Toll Road
- County
- Length of Residence in the Central Florida Area (post-deployment Only)

Age group was investigated to see if it plays a role in the percent knowledge of DMS. Figure 5 displays the frequency values for each of the two surveys for each of the age groups.

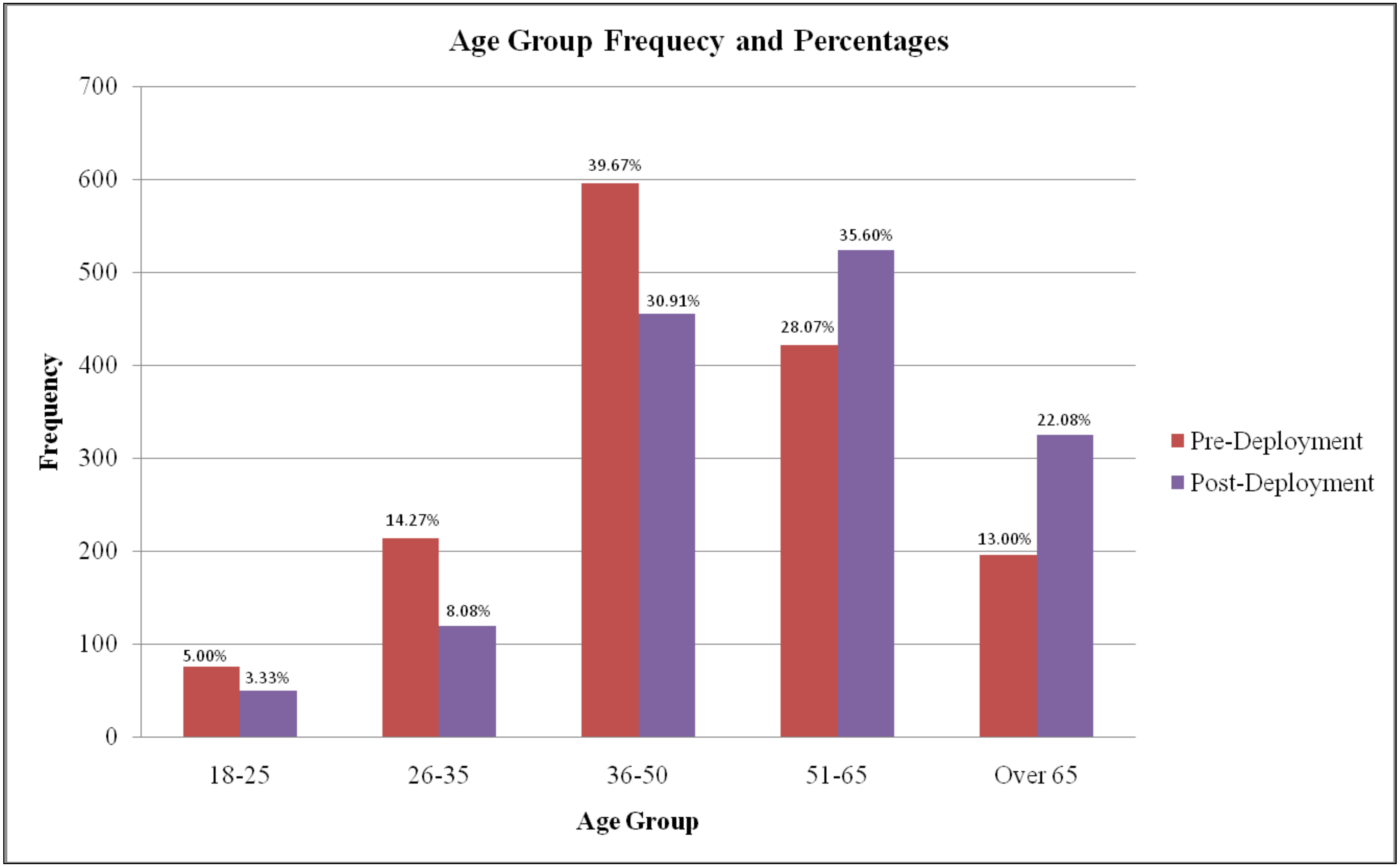

Figure 5: Age Group Frequency and Percentages

On the following pages, Figure 6 through Figure 10 show the format of the graphs that will be presented for the remainder of this section. These graphs show the distribution of percent knowledge of DMS by different classifications like Age Group, Education Level, Most Used OOCEA Toll Road, County, and Residency of Central Florida (post-deployment Only), for each of the two surveys.

Observing Figure 6 on the following page, for the pre-deployment survey, the age group 18-25 has 61.33% knowledge of DMS. The fraction to the right of the percentage displays that this 61.33% is from 46 respondents out of the total 75 respondents from this category. The percent pre-deployment survey knowledge results from this table show that the age group 26-35 as 53.27%, group 36-50 as 52.61%, group 51-65 as 55.11%, and the group Over 65 as 56.92%. There is no clear trend taken away from observing this data because the group with the highest percent knowledge is the youngest group, and this group had the smallest number of respondents to the survey. The second group percentage wise is the elderly. The lowest percent knowledge of DMS was within the age group of (36-50), which was the group with the most respondents to the survey.

For the post-deployment survey, the age group 18-25 has 63.27% knowledge of DMS. The fraction to the right of the percentage displays that this 63.27% is from 31 respondents out of the total 49 respondents from this category. The percent post-deployment survey knowledge results from this table show that the age group 26-35 as 65.55%, group 36-50 as 68.35%, group 51-65 as 63.55%, and the group Over 65 as 56.92%. Unlike the results shown for the pre-deployment survey, the youngest group (and the group with the least amount of respondents to the survey), was not the group with the highest percent knowledge of DMS. For the post-deployment survey, the age group (36-50) showed the highest percent knowledge of DMS. This is a very encouraging result as it shows that more people of the commuter group (the regular commuter age group making work trips) are becoming aware of DMS on OOCEA toll roads.

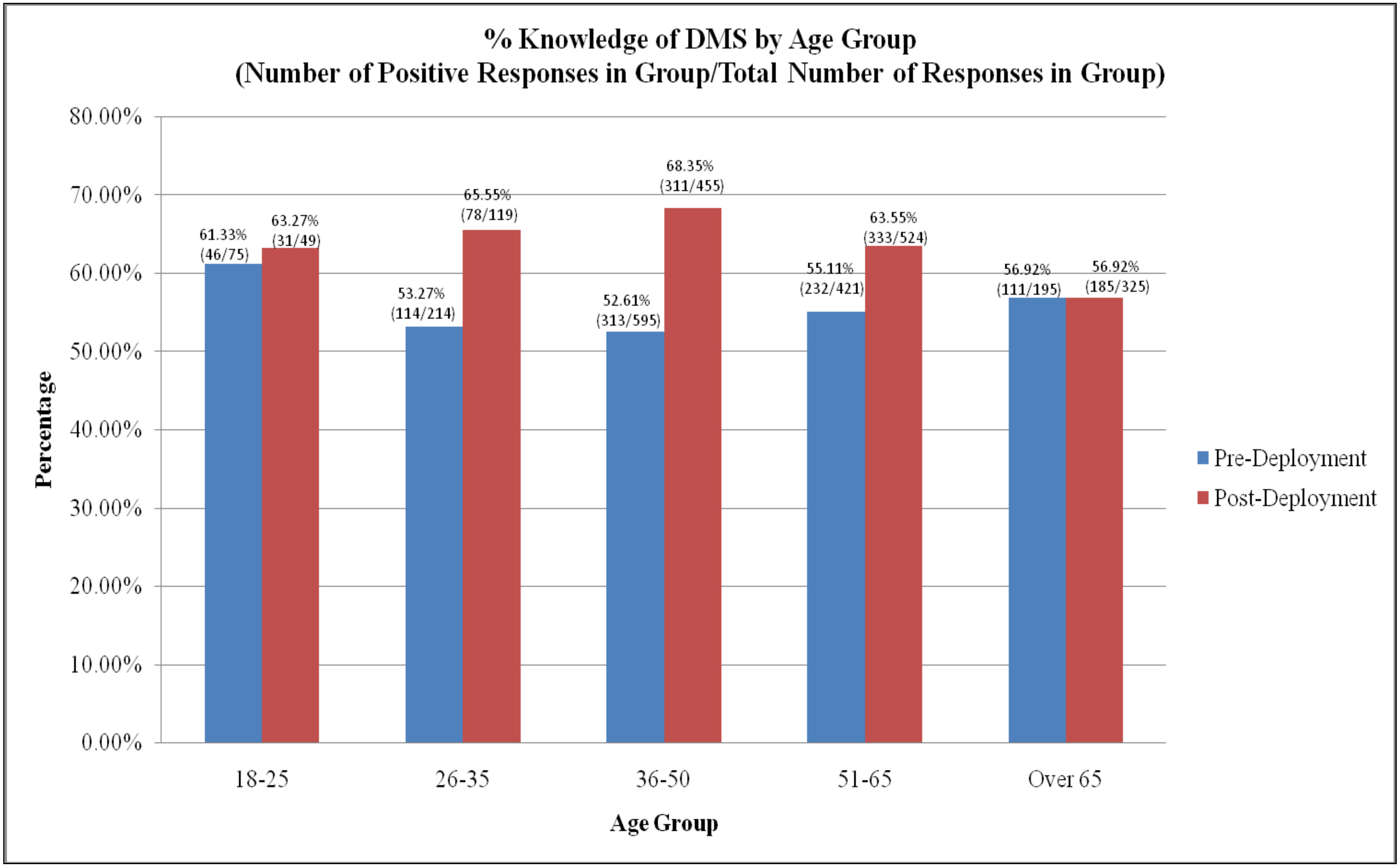

Figure 6: Percent Knowledge of DMS by Age Group

Observing Figure 7 on the following page, for the pre-deployment survey, the percent knowledge of DMS by education level shows to be somewhat random. The education level which showed the highest percent knowledge of DMS was the “Some College” level with 56.63%. The education level showing the lowest percent knowledge of DMS was the “Post Graduate Degree” level with 50.00%. There is no clear pattern for this distribution, but it is encouraging to know that, unlike the age group distribution, the level with the least amount of survey responses did not show the highest percentage of DMS knowledge. The level with the least amount of survey responses was the “Associate Degree” level with only 148 responses. This level showed a 52.70% knowledge of DMS.

For the post-deployment survey, the percent knowledge of DMS by education level does show a pattern. This distribution shows that the three higher levels of education have a higher percentage of knowledge of DMS. The education level showing the highest percent knowledge of DMS was the “Associate Degree” level with 68.67%. The education level showing the lowest percent knowledge of DMS was the “High School or Less” level with 58.30%. Although the education level with the least amount of survey responses, “Associate Degree”, had the highest percent knowledge of DMS, this distribution does not seem to show a bias as the education level with the most survey responses, “Bachelor Degree” had the second highest percent knowledge of DMS at 67.67%.

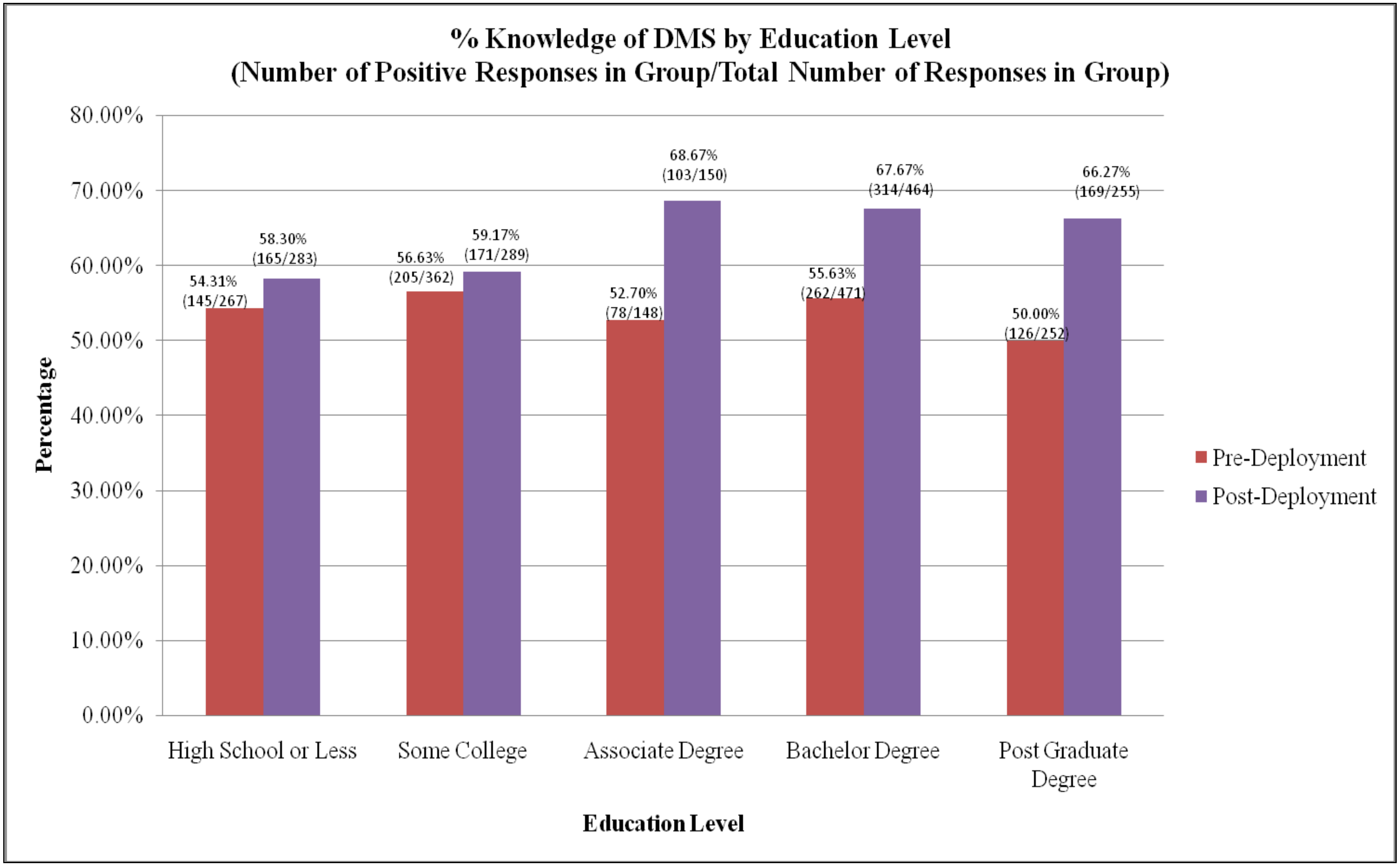

Figure 7: Percent Knowledge of DMS by Education Level

Observing Figure 8 of the following page, for the pre-deployment survey, the percent knowledge of DMS by most traveled OOCEA toll road shows to be somewhat random. The highest percent knowledge of DMS was for respondents that travel mostly on SR 408 at 57.25%. This result was somewhat expected, since the only DMS on the OOCEA toll road network at the time of the pre-deployment survey was located on this route. The lowest percent knowledge of DMS was for respondents that travel mostly on SR 528 at 51.85%.

For the post-deployment survey, the percent knowledge of DMS by most traveled OOCEA toll road showed a similar pattern to the pre-deployment survey. The distribution showed that travelers on OOCEA toll roads SR408 and SR417 have a much higher percent knowledge of DMS than the travelers of SR 429 and SR 528. As with the pre-deployment survey, this is to be expected because most of the DMS were placed on these two routes. The highest percent knowledge of DMS was for respondents that travel mostly on SR 408 at 70.13%. The lowest percent knowledge of DMS was for respondents that travel mostly on SR 528 at 54.36%. The large increase in knowledge for both SR 408 (approximately 13%) and SR 417 (approximately 10%) from the pre-deployment survey to the post-deployment survey shows that the travelers are becoming more and more aware of the DMS on these two toll roads which have seen the maximum deployment in the period between the two surveys (10 on SR408 and 9 on SR417). Also, it is encouraging to see that the two toll roads with the largest amount of responses show the highest percent knowledge of DMS. This shows that the DMS are located in the right areas.

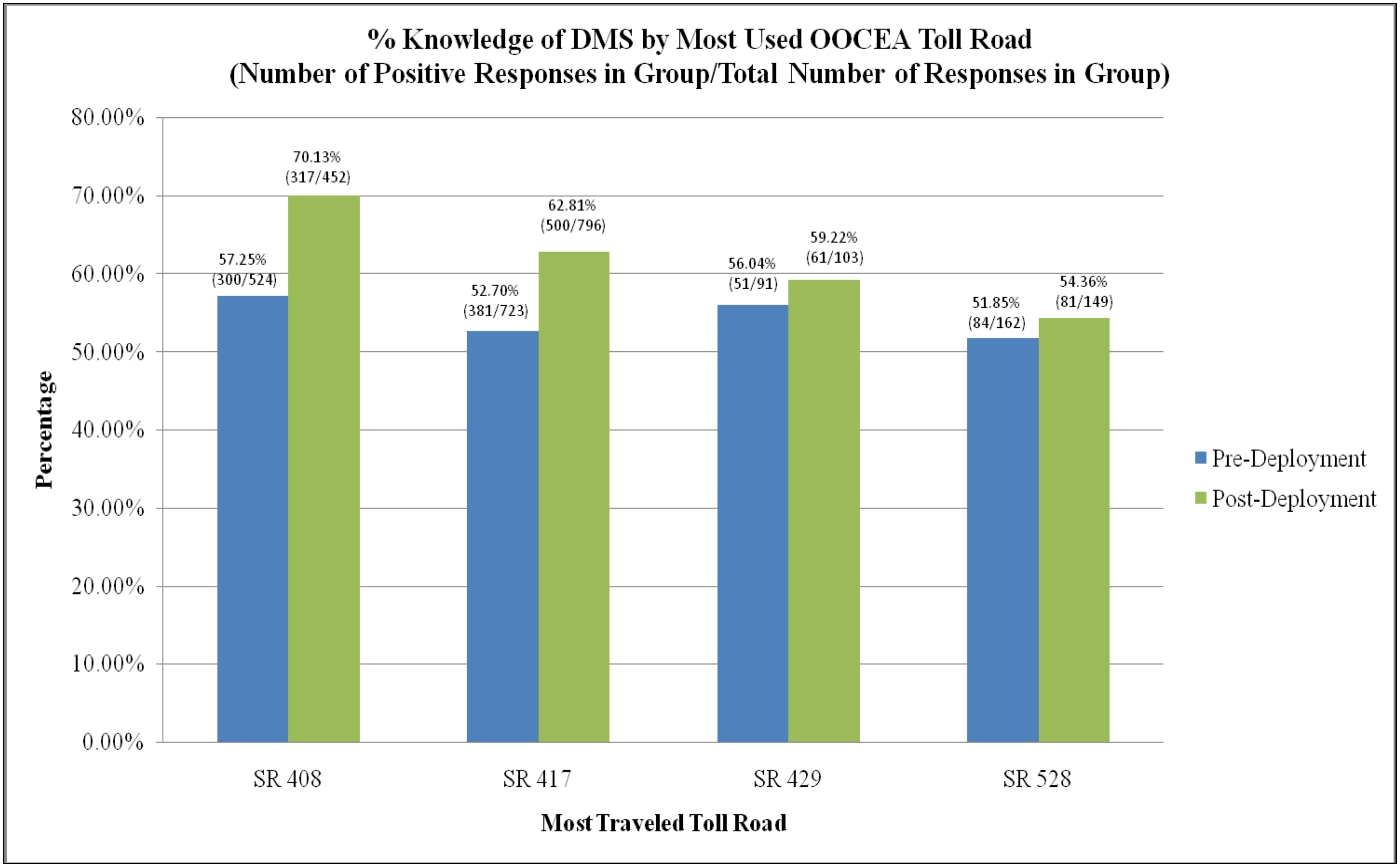

Figure 8: Percent Knowledge of DMS by Most Used OOCEA Toll Road

Observing Figure 9 on the following page, for the pre-deployment survey, the percent knowledge of DMS by county shows a particular pattern. The highest percent knowledge of DMS was for respondents that live in Orange County at 58.00%. This result was somewhat expected, since the only DMS on the OOCEA toll road network at the time of the pre-deployment survey was located in this county. The lowest percent knowledge of DMS was for respondents that live in Seminole County at 51.50%.

For the post-deployment survey, the percent knowledge of DMS by county also showed a particular pattern. The distribution showed that travelers that live in Orange and Seminole counties have a much higher percent knowledge of DMS than the travelers that live in Osceola County. As with the pre-deployment survey, this is to be expected because most of the DMS were placed in these two counties. The highest percent knowledge of DMS was for respondents that live in Orange County at 68.00%. The lowest percent knowledge of DMS was for respondents that live in Osceola County at 58.20%. The large increase in knowledge for both Orange and Seminole counties from the pre-deployment survey to the post-deployment survey shows that the travelers are becoming more and more aware of the DMS on the OOCEA toll road network.

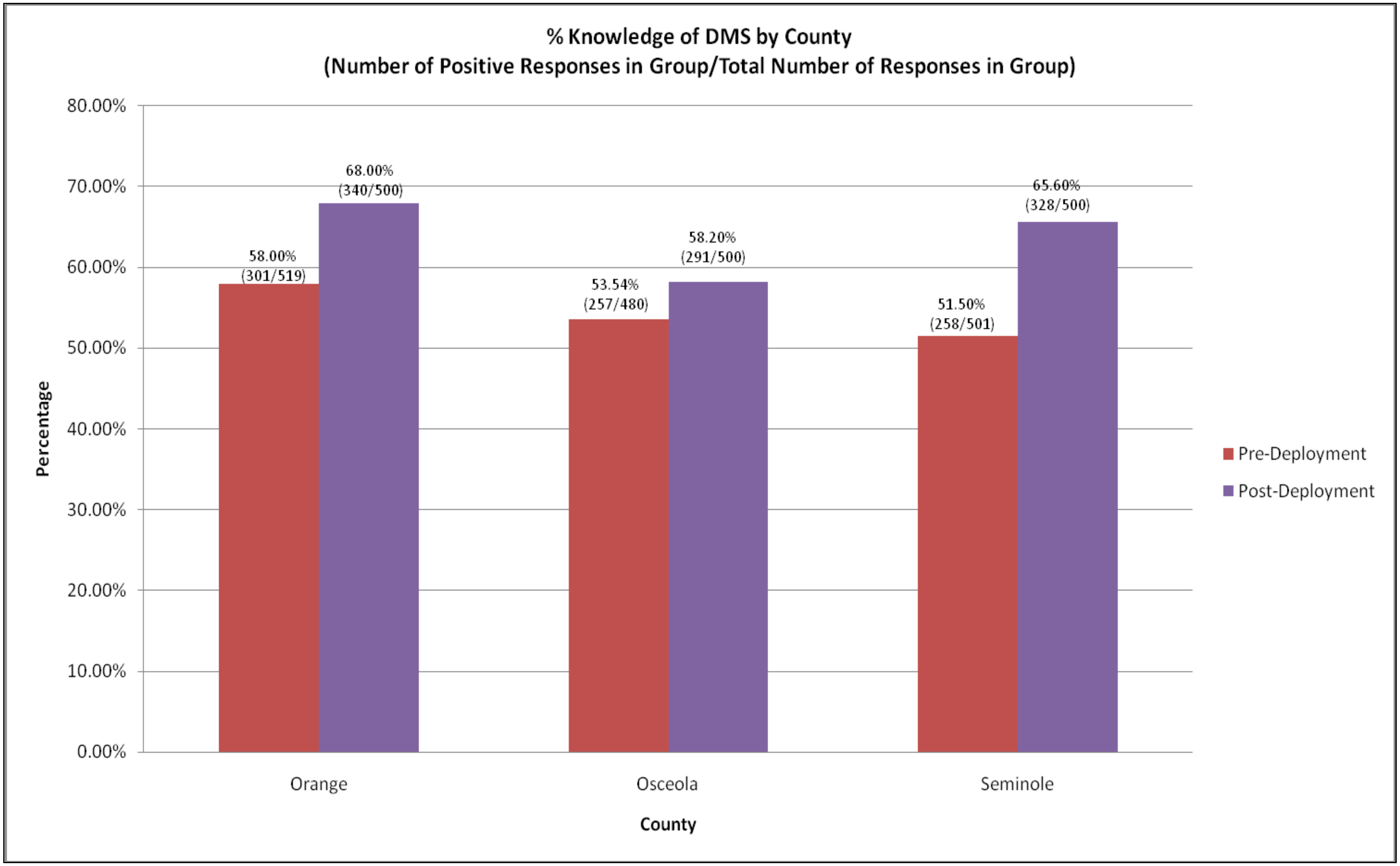

Figure 9: Percent Knowledge of DMS by County

Observing Figure 10 (the distribution of the knowledge based on the time of residency in Central Florida) on the following page, for the post-deployment survey, it is clear that the majority of respondents lived in the Central Florida area more than ten years. A majority of these long-term residents are aware of the DMS on the toll roads. Since this question was absent in the pre-deployment survey, it is not possible to compare this metric for Pre and post-deployment surveys.

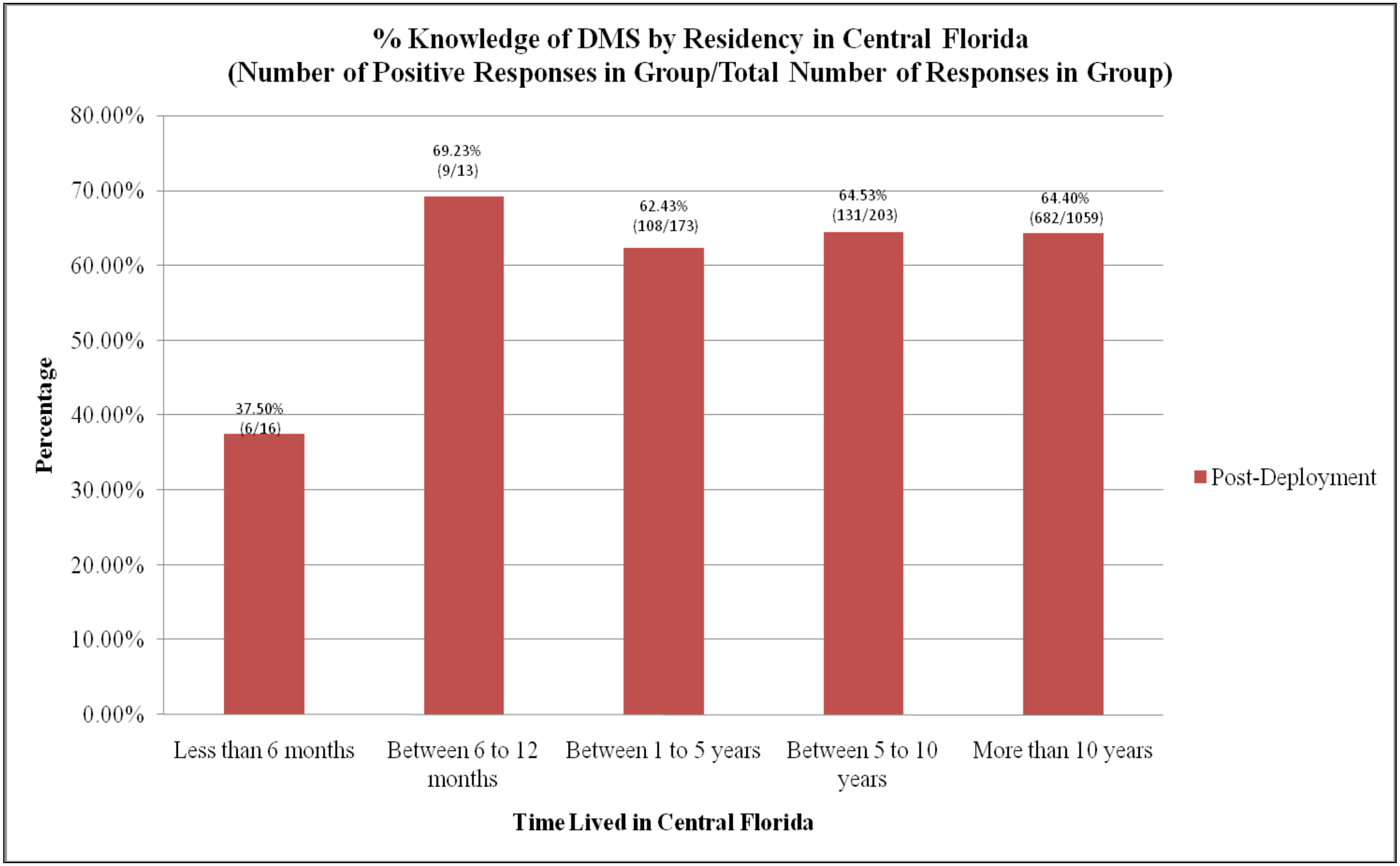

Figure 10: Percent Knowledge of DMS by Time Lived in Central Florida

4.3 DMS Satisfaction Results

The following DMS questions covered were only asked to the 816 (pre-deployment) and 959 (post-deployment) respondents who recalled seeing DMS.

The questions covered in this section consist of how the respondent agrees or disagrees with issues that concentrate on the satisfaction of a DMS subject. The questions consist of the following subjects of DMS:

- Improves travel experience
- Helpful about hazards
- Helpful with special event information
- Easy to read while driving
- Travel time accuracy
- Helped save time
- Overall satisfaction of traveler information while driving on OOCEA toll roads

The DMS questions are covered in the same order they appeared on each of the two surveys. The grading system is broken down in the following Table 3. The satisfaction with different subjects with the DMS was measured by assigning a numeric value to each of the responses. This method was used to evaluate the satisfaction of subjects like the grade point average of a class of students. It should be noted that both the pre and post-deployment survey results are presented, but the most important result is the post-deployment results. The pre-deployment results are presented to show an increase or decrease in satisfaction with increased deployment.

Table 3: Grading System Breakdown

Response	Numeric Value Assigned
Strongly Agree	4
Agree	3
Disagree	2
Strongly Disagree	1

The grade averages were used to rank each question against other questions, and to rank different variables. The variables included in the following tables are:

- Age group
- Education level
- Most used OOCEA toll road
- County
- Length of residence in central Florida (post-deployment only)

Observing Table 4 on page 64, for the pre-deployment survey, question 11 (Improves Traveling Experience) scored the third highest overall when compared with the other six satisfaction questions (3.23/4.00). Observing the categories, the age group that showed the highest satisfaction grade was 18-25 (3.41/4.00), and the age group that showed the lowest satisfaction grade was 36-50 and 26-35 (3.19/4.00). The education level showing the highest satisfaction grade was “Associate Degree” (3.42/4.00), and the education level that showed the lowest satisfaction grade was “Post Graduate Degree” (3.11/4.00). The highest satisfaction grade was shown for people that travel mostly on SR 429 (3.33/4.00), and the lowest satisfaction grade was shown for people that travel mostly on SR 528 (3.12/4.00). Finally the county showing the highest satisfaction grade was Seminole County (3.27/4.00), and the county showing the lowest satisfaction grade was Orange County (3.17/4.00).

For the post-deployment survey, question 13 (Improves Traveling Experience) scored the third highest overall when compared with the other six satisfaction questions (3.143/4.00). This is an encouraging result as this is consistent with the pre-deployment survey. This satisfaction grade is shown to be lower than that of the pre-deployment survey, but under further investigation, a larger percentage of people Strongly Agree or Agree during the post-deployment survey (86%) than during the pre-deployment survey (85%). The percentages of Strongly Agree and Agree respectively for the post-deployment survey are 31.28% and 54.74%. The percentages of Strongly Agree and Agree respectively for the pre-deployment survey are 41.79% and 43.26%. The lower average satisfaction grade of 3.143 may be caused by a larger percentage of Strongly Agree during the pre-deployment survey and a larger ratio of Agree to Strongly Agree during the post-deployment survey. Upon further comparison using a statistical z-test for proportion, there is no significant change in the percentage of satisfaction between the Pre and post-deployment surveys. The age group that showed the highest satisfaction grade was 36-50 (3.17/4.00), and the age group that showed the lowest satisfaction grade was 26-35 (3.04/4.00). This is an encouraging result which shows a larger proportion of respondents of the commuter commuter group are becoming more satisfied with the DMS. The education level that showed the highest satisfaction grade was “High School Diploma or Less” (3.42/4.00), and the education level that showed the lowest satisfaction level was “Post Graduate Degree” (3.04/4.00). The highest satisfaction grade was shown for people that travel mostly on SR 429 (3.21/4.00), and the lowest satisfaction grade was shown for people that travel mostly on SR 408 (3.09/4.00). Finally, the county that showed the highest satisfaction level was Seminole County (3.53/4.00), and the county that showed the lowest satisfaction level was Osceola County (2.82/4.00).

Table 4: DMS Grade Results for Question 11 (Pre)/Question 13(Post)

PRE-DEPLOYMENT SATISFACTION GRADES									
DMS Subject				Mode 1		Mode 2		Average Grade	
Improve Traveling Experience (Question 11)				Agree (353)		Strongly Agree (341)		3.23 (816)	
				Percent Strongly Agree		Percent Agree		Total	
				41.79% (341/816)		43.26% (353/816)		85.05% (694/816)	
Category-Wise Grades for pre-deployment Question 11									
Age	**Grade**	**Education Level**	**Grade**	**OOCEA Toll Road**	**Grade**	**Residence**	**Grade**	**County**	**Grade**
18-25	**3.41**	High School Diploma or Less	3.30	SR 408	3.23	Less than 6 months	-	Orange	3.17
26-35	3.19	Some College	3.28	SR 417	3.24	Between 6 to 12 months	-	**Seminole**	**3.27**
36-50	3.19	**Associate Degree**	**3.42**	**SR 429**	**3.33**	Between 1 to 5 years	-	Osceola	3.25
51-65	3.24	Bachelor Degree	3.15	SR 528	3.12	Between 5 to 10 years	-		
Over 65	3.28	Post Graduate Degree	3.11			More than 10 years	-		
POST-DEPLOYMENT SATISFACTION GRADES									
DMS Subject				Mode 1		Mode 2		Average Grade	
Improve Traveling Experience (Question 13)				Agree (525)		Strongly Agree (300)		3.143 (959)	
				Percent Strongly Agree		Percent Agree		Total	
				31.28% (300/959)		54.74% (525/959)		86.03% (825/959)	
Category-Wise Grades for post-deployment Question 13									
Age	**Grade**	**Education Level**	**Grade**	**OOCEA Toll Road**	**Grade**	**Residence**	**Grade**	**County**	**Grade**
18-25	3.16	**High School Diploma or Less**	**3.23**	SR 408	3.09	**Less than 6 months**	**3.33**	Orange	3.13
26-35	3.04	Some College	3.15	SR 417	3.17	Between 6 to 12 months	2.89	**Seminole**	**3.53**
36-50	**3.17**	Associate Degree	3.20	**SR 429**	**3.21**	Between 1 to 5 years	3.00	Osceola	2.82
51-65	3.16	Bachelor Degree	3.14	SR 528	3.15	Between 5 to 10 years	3.07		
Over 65	3.11	Post Graduate Degree	3.04			More than 10 years	3.18		
Z-test Statistic for Proportion				95% Significant					
0.5845671				NO					

Observing Table 5 on page 67, for the pre-deployment survey, question 12 (Helpful with Hazard Warnings) scored the highest overall when compared with the other six satisfaction questions (3.34/4.00). Observing the categories, the age group that showed the highest satisfaction grade was 18-25 (3.43/4.00), and the age group that showed the lowest satisfaction grade was 26-35 (3.31/4.00). The education level showing the highest satisfaction grade was “Associate Degree” (3.47/4.00), and the education level that showed the lowest satisfaction grade was “Post Graduate Degree” (3.18/4.00). The highest satisfaction grade was shown for people that travel mostly on SR 429 (3.43/4.00), and the lowest satisfaction grade was shown for people that travel mostly on SR 408 (3.30/4.00). Finally, the county showing the highest satisfaction grade was Osceola County (3.40/4.00), and the county showing the lowest satisfaction grade was Orange County (3.26/4.00).

For the post-deployment survey, question 14 (Helpful with Hazard Warnings) scored the second highest overall when compared with the other six satisfaction questions (3.223/4.00). This result is also encouraging to see that although this result is not the same as the pre-deployment survey result it is still one of the highest overall satisfaction grades. This satisfaction grade is shown to be lower than that of the pre-deployment survey. Also, under further investigation, a slightly larger percentage of people Strongly Agree or Agree during the pre-deployment survey (90.4%) than during the post-deployment survey (89.8%). The percentages of Strongly Agree and Agree respectively for the pre-deployment survey are 45.83% and 44.61%. The percentages of Strongly Agree and Agree respectively for the post-deployment survey are 34.73% and 55.06%. Upon further comparison using a statistical z-test for proportion, there is no significant change in the percentage of satisfaction between the Pre and post-deployment surveys. The age group that showed the highest satisfaction grade was 51-65

(3.243/4.00), and the age group that showed the lowest satisfaction grade was 26-35 (3.17/4.00). The education level that showed the highest satisfaction grade was “High School Diploma or Less” (3.31/4.00), and the education level that showed the lowest satisfaction level was “Post Graduate Degree” (3.17/4.00). The highest satisfaction grade was shown for people that travel mostly on SR 429 (3.38/4.00), and the lowest satisfaction grade was shown for people that travel mostly on SR 408 (3.17/4.00). Finally, the county that showed the highest satisfaction level was Seminole County (3.59/4.00), and the county that showed the lowest satisfaction level was Osceola County (2.91/4.00).

Table 5: DMS Grade Results for Question 12 (Pre)/Question 14 (Post)

PRE-DEPLOYMENT SATISFACTION GRADES									
DMS Subject				Mode 1		Mode 2		Average Grade	
Helpful With Hazard Warnings (Question 12)				Strongly Agree (374)		Agree (364)		3.34 (816)	
				Percent Strongly Agree		Percent Agree		Total	
				45.83% (374/816)		44.61% (364/816)		90.44% (738/816)	
Category-Wise Grades for pre-deployment Question 12									
Age	**Grade**	**Education Level**	**Grade**	**OOCEA Toll Road**	**Grade**	**Residence**	**Grade**	**County**	**Grade**
18-25	**3.43**	High School Diploma or Less	3.40	SR 408	3.30	Less than 6 months	-	Orange	3.26
26-35	3.31	Some College	3.41	SR 417	3.35	Between 6 to 12 months	-	Seminole	3.37
36-50	3.32	**Associate Degree**	**3.47**	**SR 429**	**3.43**	Between 1 to 5 years	-	**Osceola**	**3.40**
51-65	3.36	Bachelor Degree	3.27	SR 528	3.36	Between 5 to 10 years	-		
Over 65	3.34	Post Graduate Degree	3.18			More than 10 years	-		
POST-DEPLOYMENT SATISFACTION GRADES									
DMS Subject				Mode 1		Mode 2		Average Grade	
Helpful With Hazard Warnings (Question 14)				Agree (528)		Strongly Agree (333)		3.223 (959)	
				Percent Strongly Agree		Percent Agree		Total	
				34.73% (333/959)		55.06% (528/959)		89.78% (861/959)	
Category-Wise Grades for post-deployment Question 14									
Age	**Grade**	**Education Level**	**Grade**	**OOCEA Toll Road**	**Grade**	**Residence**	**Grade**	**County**	**Grade**
18-25	3.19	**High School Diploma or Less**	**3.31**	SR 408	3.17	**Less than 6 months**	**3.33**	Orange	3.22
26-35	3.17	Some College	3.25	SR 417	3.24	Between 6 to 12 months	3.00	**Seminole**	**3.59**
36-50	3.241	Associate Degree	3.21	**SR 429**	**3.38**	Between 1 to 5 years	3.13	Osceola	2.91
51-65	**3.243**	Bachelor Degree	3.20	SR 528	3.23	Between 5 to 10 years	3.13		
Over 65	3.21	Post Graduate Degree	3.17			More than 10 years	3.26		
Z-test Statistic for Proportion				95% Significant					
-0.4637871				NO					

Observing Table 6 on page 70, for the pre-deployment survey, question 13 (Special Event Information) scored the lowest overall when compared with the other six satisfaction questions (2.90/4.00). Observing the categories, the age group that showed the highest satisfaction grade was 18-25 (3.07/4.00), and the age group that showed the lowest satisfaction grade was 36-50 (2.88/4.00). The education level showing the highest satisfaction grade was “Associate Degree” (3.09/4.00), and the education level that showed the lowest satisfaction grade was “Post Graduate Degree” (2.67/4.00). The highest satisfaction grade was shown for people that travel mostly on SR 429 (2.94/4.00), and the lowest satisfaction grade was shown for people that travel mostly on SR 408 or SR 528 (2.87/4.00). Finally, the county showing the highest satisfaction grade was Osceola County (3.02/4.00), and the county showing the lowest satisfaction grade was Orange County (2.83/4.00).

For the post-deployment survey, question 15 (Special Event Information) scored the second lowest overall when compared with the other six satisfaction questions (2.917/4.00). This result also is consistent with the pre-deployment Survey result as it is still one of the lowest overall satisfaction grades. This satisfaction grade is shown to be higher than that of the pre-deployment survey. Also, under further investigation, a larger percentage of people Strongly Agree or Agree during the post-deployment survey (74.5%) than during the pre-deployment survey (68.9%). The percentages of Strongly Agree and Agree respectively for the post-deployment survey are 22.00% and 52.45%. The percentages of Strongly Agree and Agree respectively for the pre-deployment survey are 28.06% and 40.81%. Upon further comparison using a statistical z-test for proportion, it is shown that there is a significant change in the percentage of satisfaction between the Pre and post-deployment surveys. The results of the statistical test show a significant increase in satisfaction between the Pre and post-deployment surveys with respect to satisfaction with special event information on DMS. The age group that showed the highest satisfaction grade was Over 65 (3.02/4.00), and the age group that showed the lowest satisfaction grade was 26-35 (2.83/4.00). This is an encouraging result which shows respondents of a larger commuter group are becoming more satisfied with the DMS. The education level that showed the highest satisfaction grade was “High School Diploma or Less” (3.05/4.00), and the education level that showed the lowest satisfaction level was “Post Graduate Degree” (2.79/4.00). The highest satisfaction grade was shown for people that travel mostly on SR 408 (2.95/4.00), and the lowest satisfaction grade was shown for people that travel mostly on SR 417 or SR 528 (2.90/4.00). This result however is encouraging to note because SR 408 is located near the downtown Orlando area, an area that may host a larger percentage of special events. Finally the county that showed the highest satisfaction level was Seminole County (3.22/4.00), and the county that showed the lowest satisfaction level was Osceola County (2.66/4.00).

Table 6: DMS Grade Results for Question 13 (Pre)/Question 15 (Post)

PRE-DEPLOYMENT SATISFACTION GRADES			
DMS Subject	Mode 1	Mode 2	Average Grade
Special Event Information (Question 13)	Agree (333)	Strongly Agree (229)	2.90 (816)
	Percent Strongly Agree	Percent Agree	Total
	28.06% (229/816)	40.81% (333/816)	68.87% (562/816)

Category-Wise Grades for pre-deployment Question 13									
Age	**Grade**	**Education Level**	**Grade**	**OOCEA Toll Road**	**Grade**	**Residence**	**Grade**	**County**	**Grade**
18-25	**3.07**	High School Diploma or Less	3.08	SR 408	2.87	Less than 6 months	-	Orange	2.83
26-35	2.79	Some College	3.03	SR 417	2.93	Between 6 to 12 months	-	Seminole	2.87
36-50	2.88	**Associate Degree**	**3.09**	**SR 429**	**2.94**	Between 1 to 5 years	-	**Osceola**	**3.02**
51-65	2.91	Bachelor Degree	2.76	SR 528	2.87	Between 5 to 10 years	-		
Over 65	3.00	Post Graduate Degree	2.67			More than 10 years	-		

POST-DEPLOYMENT SATISFACTION GRADES			
DMS Subject	Mode 1	Mode 2	Average Grade
Special Event Information (Question 15)	Agree (503)	Strongly Agree (211)	2.917 (959)
	Percent Strongly Agree	Percent Agree	Total
	22.00% (211/959)	52.45% (503/959)	74.45% (714/959)

Category-Wise Grades for post-deployment Question 15									
Age	**Grade**	**Education Level**	**Grade**	**OOCEA Toll Road**	**Grade**	**Residence**	**Grade**	**County**	**Grade**
18-25	2.97	**High School Diploma or Less**	**3.05**	**SR 408**	**2.95**	**Less than 6 months**	**3.00**	Orange	2.91
26-35	2.83	Some College	3.00	SR 417	2.90	Between 6 to 12 months	2.67	**Seminole**	**3.22**
36-50	2.87	Associate Degree	2.93	SR 429	2.93	Between 1 to 5 years	2.83	Osceola	2.66
51-65	2.90	Bachelor Degree	2.84	SR 528	2.90	Between 5 to 10 years	2.79		
Over 65	**3.02**	Post Graduate Degree	2.79			More than 10 years	2.95		
Z-test Statistic for Proportion				95% Significant					
2.6062291				YES					

Observing Table 7 on page 73, for the pre-deployment survey, question 14 (Easy to Read While Driving) scored the second highest overall when compared with the other six satisfaction questions (3.31/4.00). Observing the categories, the age group that showed the highest satisfaction grade was 18-25 (3.48/4.00), and the age group that showed the lowest satisfaction grade was Over 65 (3.14/4.00). The education level showing the highest satisfaction grade was "Associate Degree" (3.37/4.00), and the education level that showed the lowest satisfaction grade was "Post Graduate Degree" (3.26/4.00). The highest satisfaction grade was shown for people that travel mostly on SR 429 (3.41/4.00), and the lowest satisfaction grade was shown for people that travel mostly on SR 528 (3.20/4.00). Finally, the county showing the highest satisfaction grade was Seminole County (3.36/4.00), and the county showing the lowest satisfaction grade was Orange County (3.28/4.00).

For the post-deployment survey, question 16 (Easy to Read While Driving) scored the highest overall when compared with the other six satisfaction questions (3.251/4.00). This result is also encouraging to see that although this result is not the same as the pre-deployment survey result it is still one of the highest overall satisfaction grades. This satisfaction grade is shown to be lower than that of the pre-deployment survey, but under further investigation, a larger percentage of people Strongly Agree or Agree during the post-deployment survey (92%) than during the pre-deployment survey (91%). The percentages of Strongly Agree and Agree respectively for the post-deployment survey are 35.66% and 56.31%. The percentages of Strongly Agree and Agree respectively for the pre-deployment survey are 43.14% and 47.92%. The lower average satisfaction grade of 3.251 may be caused by a larger percentage of Strongly Agree during the pre-deployment survey and a larger ratio of Agree to Strongly Agree during the post-deployment survey. Upon further comparison using a statistical z-test for proportion, it is shown that there is no significant change in the percentage of satisfaction between the Pre and post-deployment surveys. The age group that showed the highest satisfaction grade was 26-35 (3.33/4.00), and the age group that showed the lowest satisfaction grade was Over 65 (3.05/4.00). It is to be noted that the “Over 65” age group consistently scored lowest grade in both pre- and post- deployment surveys. This result is not as encouraging as the results for other satisfaction grades as this age group is not one of the larger response groups. The education level that showed the highest satisfaction grade was “Associate Degree” (3.35/4.00), and the education level that showed the lowest satisfaction level was “Some College” (3.23/4.00). The highest satisfaction grade was shown for people that travel mostly on SR 429 (3.41/4.00), and the lowest satisfaction grade was shown for people that travel mostly on SR 528 (3.20/4.00). Finally, the county that showed the highest satisfaction level was Seminole County (3.62/4.00), and the county that showed the lowest satisfaction level was Osceola County (2.90/4.00).

Table 7: DMS Grade Results for Question 14 (Pre)/Question 16 (Post)

PRE-DEPLOYMENT SATISFACTION GRADES											
DMS Subject				Mode 1		Mode 2		Average Grade			
Easy To Read While Driving (Question 14)				Agree (391)		Strongly Agree (352)		3.31 (959)			
				Percent Strongly Agree		Percent Agree		Total			
				43.14% (352/816)		47.92% (391/816)		91.05% (743/816)			
Category-Wise Grades for pre-deployment Question 14											
Age	**Grade**	**Education Level**	**Grade**	**OOCEA Toll Road**	**Grade**	**Residence**	**Grade**	**County**	**Grade**		
18-25	**3.48**	High School Diploma or Less	3.34	SR 408	3.31	Less than 6 months	-	Orange	3.28		
26-35	3.31	Some College	3.32	SR 417	3.33	Between 6 to 12 months	-	**Seminole**	**3.36**		
36-50	3.39	**Associate Degree**	**3.37**	**SR 429**	**3.41**	Between 1 to 5 years	-	Osceola	3.32		
51-65	3.26	Bachelor Degree	3.30	SR 528	3.20	Between 5 to 10 years	-				
Over 65	3.14	Post Graduate Degree	3.26			More than 10 years	-				
POST-DEPLOYMENT SATISFACTION GRADES											
DMS Subject				Mode 1		Mode 2		Average Grade			
Easy To Read While Driving (Question 16)				Agree (540)		Strongly Agree (342)		3.251 (959)			
				Percent Strongly Agree		Percent Agree		Total			
				35.66% (342/959)		56.31% (540/959)		91.97% (882/959)			
Category-Wise Grades for post-deployment Question 16											
Age	**Grade**	**Education Level**	**Grade**	**OOCEA Toll Road**	**Grade**	**Residence**	**Grade**	**County**	**Grade**		
18-25	3.32	High School Diploma or Less	3.24	SR 408	3.25	**Less than 6 months**	**3.33**	Orange	3.28		
26-35	**3.33**	Some College	3.23	SR 417	3.24	Between 6 to 12 months	2.89	**Seminole**	**3.62**		
36-50	3.29	**Associate Degree**	**3.35**	**SR 429**	**3.41**	Between 1 to 5 years	3.16	Osceola	2.90		
51-65	3.31	Bachelor Degree	3.25	SR 528	3.20	Between 5 to 10 years	3.26				
Over 65	3.05	Post Graduate Degree	3.24			More than 10 years	3.27				
Z-test Statistic for Proportion				95% Significant							
0.6921407				NO							

Observing Table 8 on page 76, for the pre-deployment survey, question 15 (DMS Accuracy) scored the fourth highest overall when compared with the other six satisfaction questions (3.08/4.00). Observing the categories, the age group that showed the highest satisfaction grade was 18-25 (3.24/4.00), and the age groups that showed the lowest satisfaction grade was 51-65 and Over 65 (3.03/4.00). The education level showing the highest satisfaction grade was "Some College" (3.18/4.00), and the education level that showed the lowest satisfaction grade was "Bachelor Degree" (2.98/4.00). The highest satisfaction grade was shown for people that travel mostly on SR 429 (3.25/4.00), and the lowest satisfaction grade was shown for people that travel mostly on SR 408 (3.04/4.00). Finally, the county showing the highest satisfaction grade was Osceola County (3.12/4.00), and the county showing the lowest satisfaction grade was Seminole County (3.06/4.00).

For the post-deployment survey, question 17 (DMS Accuracy) scored the fourth highest overall when compared with the other six satisfaction questions (3.077/4.00). This is an encouraging result as this is consistent with the pre-deployment survey. This satisfaction grade is shown to be lower than that of the pre-deployment survey, but under further investigation, a larger percentage of people Strongly Agree or Agree during the post-deployment survey (87.4%) than during the pre-deployment survey (84%). This is a very encouraging statistic because this satisfaction level was shown to be a very influential variable in overall satisfaction. The percentages of Strongly Agree and Agree respectively for the post-deployment survey are 22.94% and 64.44%. The percentages of Strongly Agree and Agree respectively for the pre-deployment survey are 27.70% and 56.25%. The lower average satisfaction grade of 3.077 may be caused by a larger percentage of Strongly Agree during the pre-deployment survey and a larger ratio of Agree to Strongly Agree during the post-deployment survey. Upon further comparison using a statistical z-test for proportion, it is shown that there is a significant change in the percentage of satisfaction between the Pre and post-deployment surveys. The results of the statistical test show a significant increase in satisfaction between the Pre and post-deployment surveys with respect to satisfaction with travel time accuracy on DMS. The age group that showed the highest satisfaction grade was 36-50 (3.103/4.00), and the age group that showed the lowest satisfaction grade was 18-25 (2.81/4.00). This is an encouraging result which shows respondents of a larger commuter group are becoming more satisfied with the DMS. The education level that showed the highest satisfaction grade was “Associate Degree” (3.16/4.00), and the education level that showed the lowest satisfaction level was “Post Graduate Degree” (3.01/4.00). The highest satisfaction grade was shown for people that travel mostly on SR 528 (3.099/4.00), and the lowest satisfaction grade was shown for people that travel mostly on SR 417 (3.07/4.00). Finally, the county that showed the highest satisfaction level was Seminole County (3.43/4.00), and the county that showed the lowest satisfaction level was Osceola County (2.75/4.00).

Table 8: DMS Grade Results for Question 15 (Pre)/Question 17 (Post)

PRE-DEPLOYMENT SATISFACTION GRADES									
DMS Subject				Mode 1		Mode 2	Average Grade		
DMS Accuracy (Question 15)				Agree (459)		Strongly Agree (226)	3.08 (816)		
				Percent Strongly Agree		Percent Agree	Total		
				27.70% (226/816)		56.25% (459/816)	83.95% (685/816)		
Category-Wise Grades for pre-deployment Question 15									
Age	**Grade**	**Education Level**	**Grade**	**OOCEA Toll Road**	**Grade**	**Residence**	**Grade**	**County**	**Grade**
18-25	**3.24**	High School Diploma or Less	3.16	SR 408	3.04	Less than 6 months	-	Orange	3.07
26-35	3.06	**Some College**	**3.18**	SR 417	3.09	Between 6 to 12 months	-	Seminole	3.06
36-50	3.12	Associate Degree	3.15	**SR 429**	**3.25**	Between 1 to 5 years	-	**Osceola**	**3.12**
51-65	3.03	Bachelor Degree	2.98	SR 528	3.11	Between 5 to 10 years	-		
Over 65	3.03	Post Graduate Degree	3.01			More than 10 years	-		
POST-DEPLOYMENT SATISFACTION GRADES									
DMS Subject				Mode 1		Mode 2	Average Grade		
DMS Accuracy (Question 17)				Agree (618)		Strongly Agree (220)	3.077 (959)		
				Percent Strongly Agree		Percent Agree	Total		
				22.94% (220/959)		64.44% (618/959)	87.38% (838/959)		
Category-Wise Grades for post-deployment Question 17									
Age	**Grade**	**Education Level**	**Grade**	**OOCEA Toll Road**	**Grade**	**Residence**	**Grade**	**County**	**Grade**
18-25	2.81	High School Diploma or Less	3.05	SR 408	3.08	**Less than 6 months**	**3.33**	Orange	3.09
26-35	2.97	Some College	3.09	SR 417	3.07	Between 6 to 12 months	3.00	**Seminole**	**3.43**
36-50	**3.103**	**Associate Degree**	**3.16**	SR 429	3.098	Between 1 to 5 years	3.02	Osceola	2.75
51-65	3.102	Bachelor Degree	3.09	**SR 528**	**3.099**	Between 5 to 10 years	3.05		
Over 65	3.08	Post Graduate Degree	3.01			More than 10 years	3.09		
Z-test Statistic for Proportion				95% Significant					
2.0674443				YES					

Observing Table 9 on page 79, for the pre-deployment survey, question 26 (Helped Save Time) scored the second lowest overall when compared with the other six satisfaction questions (3.00/4.00). Observing the categories, the age group that showed the highest satisfaction grade was Over 65 (3.10/4.00), and the age group that showed the lowest satisfaction grade was 26-35 (2.91/4.00). The education level showing the highest satisfaction grade was “Associate Degree” (3.17/4.00), and the education level that showed the lowest satisfaction grade was “Bachelor Degree” (2.86/4.00). The highest satisfaction grade was shown for people that travel mostly on SR 429 (3.10/4.00), and the lowest satisfaction grade was shown for people that travel mostly on SR 528 (2.86/4.00). Finally, the county showing the highest satisfaction grade was Osceola County (3.04/4.00), and the county showing the lowest satisfaction grade was Orange County (2.96/4.00).

For the post-deployment survey, question 33 (Helped Save Time) scored the lowest overall when compared with the other six satisfaction questions (2.899/4.00). This result also is consistent with the pre-deployment Survey result as it is still one of the lowest overall satisfaction grades. This satisfaction grade is shown to be lower than that of the pre-deployment survey. Also, under further investigation, a larger percentage of people Strongly Agree or Agree during the pre-deployment survey (78.3%) than during the pre-deployment survey (75.6%). The percentages of Strongly Agree and Agree respectively for the pre-deployment survey are 27.45% and 50.86%. The percentages of Strongly Agree and Agree respectively for the post-deployment survey are 18.77% and 56.83%. Upon further comparison using a statistical z-test for proportion, it is shown that there is no significant change in the percentage of satisfaction between the Pre and post-deployment surveys. The age group that showed the highest satisfaction grade was 36-50 (2.94/4.00), and the age group that showed the lowest satisfaction grade was 26-35 (2.68/4.00). This is an encouraging result which shows respondents of a larger commuter group are becoming more satisfied with the DMS. The education level that showed the highest satisfaction grade was “High School Diploma or Less” (3.04/4.00), and the education level that showed the lowest satisfaction level was “Post Graduate Degree” (2.80/4.00). The highest satisfaction grade was shown for people that travel mostly on SR 429 (2.95/4.00), and the lowest satisfaction grade was shown for people that travel mostly on SR 408 (2.85/4.00). Finally, the county that showed the highest satisfaction level was Seminole County (3.20/4.00), and the county that showed the lowest satisfaction level was Osceola County (2.68/4.00).

Table 9: DMS Grade Results for Question 26 (Pre)/Question 33 (Post)

PRE-DEPLOYMENT SATISFACTION GRADES			
DMS Subject	Mode 1	Mode 2	Average Grade
Helped Save Time (Question 26)	Agree (415)	Strongly Agree (224)	3.00 (816)
	Percent Strongly Agree	Percent Agree	Total
	27.45% (224/816)	50.86% (415/816)	78.31% (639/816)

Category-Wise Grades for pre-deployment Question 26									
Age	**Grade**	**Education Level**	**Grade**	**OOCEA Toll Road**	**Grade**	**Residence**	**Grade**	**County**	**Grade**
18-25	3.04	High School Diploma or Less	3.12	SR 408	2.99	Less than 6 months	-	Orange	2.96
26-35	2.91	Some College	3.07	SR 417	3.02	Between 6 to 12 months	-	Seminole	3.01
36-50	2.97	**Associate Degree**	**3.17**	**SR 429**	**3.10**	Between 1 to 5 years	-	**Osceola**	**3.04**
51-65	3.02	Bachelor Degree	2.86	SR 528	2.86	Between 5 to 10 years	-		
Over 65	**3.10**	Post Graduate Degree	2.92			More than 10 years	-		

POST-DEPLOYMENT SATISFACTION GRADES			
DMS Subject	Mode 1	Mode 2	Average Grade
Helped Save Time (Question 33)	Agree (545)	Disagree (191)	2.899 (959)
	Percent Strongly Agree	Percent Agree	Total
	18.77% (180/959)	56.83% (545/959)	75.6% (725/959)

Category-Wise Grades for post-deployment Question 33									
Age	**Grade**	**Education Level**	**Grade**	**OOCEA Toll Road**	**Grade**	**Residence**	**Grade**	**County**	**Grade**
18-25	2.77	**High School Diploma or Less**	**3.04**	SR 408	2.85	**Less than 6 months**	**3.00**	Orange	2.85
26-35	2.68	Some College	3.01	SR 417	2.92	Between 6 to 12 months	2.78	**Seminole**	**3.20**
36-50	**2.94**	Associate Degree	2.88	**SR 429**	**2.95**	Between 1 to 5 years	2.76	Osceola	2.68
51-65	2.92	Bachelor Degree	2.81	SR 528	2.94	Between 5 to 10 years	2.83		
Over 65	2.93	Post Graduate Degree	2.80			More than 10 years	2.94		

Z-test Statistic for Proportion	95% Significant
-1.3485686	NO

4.4 Significance Test for the Difference of Percentages between the Pre and Post-Deployment surveys

The question to be covered in this section is if there is a significant difference shown between the pre-deployment and post-deployment surveys in two important study variables. The two important variables tested in this section are as follows:

- Percent knowledge of DMS
- Overall satisfaction with traffic information on OOCEA toll roads

Along with these two important study variables, one other variable will be tested as well, the percentage of survey responses that Strongly Agree or Agree that travel time on DMS signs are accurate. Equation 1 below shows the equation used to show if there is a significant difference between the Pre and post-deployment surveys:

$$Z - Statistic = \frac{\hat{p}_{post} - \hat{p}_{pre}}{s_p}$$

Where:

$$\hat{p}_{post} = post - deployment\ proportion$$

$$\hat{p}_{pre} = pre - deployment\ proportion$$

$$s_p = \sqrt{\hat{p}\,\hat{q}\left(\frac{1}{n_{post}} + \frac{1}{n_{pre}}\right)}$$

$$\hat{p} = \frac{post - deployment\ frequency + pre - deployment\ frequency}{n_{post} + n_{pre}}$$

$$\hat{q} = (1 - \hat{p})$$

Equation 1: Z-Statistic for proportions (50)

Table 10 below shows the variables and results shown for the significant difference for the percent knowledge of DMS.

Table 10: Z-Test for Significant Difference between Pre and Post-Deployment for DMS Knowledge

DMS Knowledge						
Deployment	**Frequency**	**Percentage**	**Proportion (pi)**	**Proportion (p)**	**Z-Statistic**	**Significant**
Pre	816	54.40%	54.40%	0.592	5.31165	YES
Post	959	63.93%	63.93%			

As it can be seen from the table above, a significant difference is shown in the percent knowledge of DMS from the Pre and post-deployment surveys. This Z-Statistic shows nearly a 100% significant difference between the Pre and post-deployment surveys. This is a very encouraging result as it shows that there much more people are becoming aware of DMS on the OOCEA toll roads.

Table 11 below shows the variables and results shown for significant difference for the overall satisfaction (only with respondents who showed knowledge of DMS) with traffic information on OOCEA toll roads:

Table 11: Z-Test for a Significant Difference between Pre and Post-Deployment for Overall Satisfaction

Satisfaction						
Deployment	**Frequency**	**Percentage**	**Proportion (pi)**	**Proportion (p)**	**Z-Statistic**	**Significant**
Pre	687	84.19%	0.8419	0.500	0.37733	NO
Post	814	84.88%	0.8488			

As it can be seen from the table above, there is no significant difference shown in the overall satisfaction of traffic information on OOCEA toll roads (based on prior knowledge of DMS on toll roads) from the pre and post-deployment surveys.

4.5 DMS Preferred Formats and Abbreviations, and Benefits

The following tables display the results and comparisons between the pre and post-deployment surveys. It should be noted that for the following preferred formats, only the opinions of local residents were used. With the addition of the opinions of tourist, these preferred formats may differ. These results and comparisons are summarized below:

The following Tables have the results only of the 816 pre-deployment respondents and 959 post-deployment respondents who were aware of DMS from the DMS knowledge question. The first question discussed dealt with pre-deployment question 17 and post-deployment questions 37 and 38, the preferred message format when showing abnormal traffic situations. In the pre-deployment survey, this question only had three responses, all flashing message, one line flashing message, and non-flashing message. In the post-deployment survey this was altered upon request of OOCEA to include four responses, steady message, flashing message, two page message describing the traffic situation and the travel time, and flashing beacon on top of DMS. Another alteration to this question between the two surveys is that this question was only asked to people stating that they should be alerted of abnormal traffic situations by DMS. Table 12 shows the results of post-deployment survey question 37, if the traveler would like to be informed of abnormal traffic situations.

Table 12: Should DMS Inform You of Abnormal Traffic Situations

Variable	Frequency	Percentage
Yes	901	93.95%
No	58	6.05%

From Table 13 on the following page the results show that when a message on DMS displays abnormal traffic conditions, the mode of the pre-deployment travelers (42.65%)

responds they would prefer a non-flashing message. The mode of the post-deployment travelers (40.07%) responds they would prefer a flashing message. This is contradicting the results of the pre-deployment survey, but this could be because, if you add up both all flashing and one line flashing message from the pre-deployment survey, it would show that any type of flashing message would be preferred.

Table 13: What is Preferred for Abnormal Traffic Conditions (Pre Q17/Post Q38)

Pre-Deployment Results		
Variable	**Frequency**	**Percentage**
A.) All Flashing Message	256	31.37%
B.) One Line Flashing Message	212	25.98%
C.) Non Flashing Message	**348**	**42.65%**
Total Responses	816	100.00%
Post-Deployment Results		
Variable	**Frequency**	**Percentage**
A.) Steady Message	269	29.86%
B.) Flashing Message	**361**	**40.07%**
C.) Two Page Message	154	17.09%
D.) Flashing Beacon	117	12.99%
Total Responses	901	100.00%

The second question discussed dealt with pre-deployment question 25 and post-deployment question 32, how did DMS help you reschedule your travel. This question was identical in both the pre and post-deployment survey. From Table 14 the results show that for the pre-deployment survey results, the mode (57.48%) of travelers stated that DMS helped them reschedule by helping them inform someone that they are running late. For the post-deployment survey results, the mode (53.28%) of travelers also stated that DMS helped them reschedule by informing someone that they are running late. This is an encouraging result as the post-deployment response is consistent with the pre-deployment results.

Table 14: DMS Helped Reschedule Travel Plans (Pre Q25/Post Q32)

Pre-Deployment Results		
Variable	**Frequency**	**Percentage**
A.) Adding unintended intermediate stops	57	6.99%
B.) Canceling intended intermediate stops	25	3.06%
C.) Informing someone that you are running late	**469**	**57.48%**
D.) Other	80	9.80%
E.) It did not help with rescheduling	185	22.67%
Total responses	816	100.00%
Post-Deployment Results		
Variable	**Frequency**	**Percentage**
A.) Adding unintended intermediate stops	41	4.28%
B.) Canceling intended intermediate stops	28	2.92%
C.) Informing someone that you are running late	**511**	**53.28%**
D.) Other	142	14.81%
E.) It did not help with rescheduling	237	24.71%
Total responses	959	100.00%

The third question discussed dealt with pre-deployment question 28 and post-deployment questions 34, 35, and 36, how would you prefer the format on DMS for roadway names. This question was identical in both the pre and post-deployment survey, yet as recommended by OOCEA, the same roadway was not asked in both the pre and post-deployment survey. In total, 4 different roadway names were used between the two surveys. From Table 15 the results show that for the pre-deployment survey results, with respect to Colonial (SR 50), 54.70% of respondents would prefer the DMS format to show the state road number. With respect to Semoran (SR 436), 66.53% of the respondents would prefer the format to show the state road number. With respect to Aloma (SR 426), 62.98% of the respondents would prefer the format to show the roadway name. With respect to Alafaya (SR 434), 50.47% of the respondents would prefer the format to show the state road number. These results show that the majority of people prefer the state road number format for these three roadways, but it can also be shown that the results vary according to roadway.

Table 15: Roadway Name Preference on DMS

Pre-Deployment Results		
	State Road Number	**Road Name**
Colonial	54.70%	45.30%
Post-Deployment Results		
	State Road Number	**Road Name**
Semoran	66.53%	33.47%
Aloma	37.02%	62.98%
Alafaya	50.47%	49.53%

The following Table 16 through Table 18 deals with formatting questions that were only asked during the pre-deployment survey. Table 16 shows the results for pre-deployment survey question 16 (the preferred format of message on DMS – question was only asked to respondents with prior knowledge of DMS), Table 17 shows the results for pre-deployment survey questions 27 (preference towards using abbreviations for street names), Table 18 shows the results for pre-deployment survey question 29 (interpretation of travel time message to the Airport exit).

From Table 16 below, the results show that with 63.5%, the majority of toll road users preferred DMS with steady message, and not alternating. An alternating message, for example, would be a two-page message, and a steady message would be one page.

Table 16: What is Preferred on DMS (Q16)

Variable	Frequency	Percent (%)
A) Steady Message	**518**	**63.5%**
B) Alternating Message	298	36.5%
# of Respondents Who Answered Q16	816	100.0%

From Table 14 below, the mode for Question 27 (satisfaction of I-Drive Abbreviation) was "agree." The second mode to this question was "strongly agree." Totally, 16.1% of the respondents "disagree" or "strongly disagree," hence, 83.9% of the respondents find the abbreviation acceptable.

Table 17: I-Drive as Abbreviation of International Drive (Q27)

Variable	Frequency	Percent (%)
A) Strongly Agree	586	39.1%
B) Agree	**673**	**44.9%**
C) Disagree	153	10.2%
D) Strongly Disagree	88	5.9%
# of Respondents Who Answered Q27	1500	100.0%

Below, Table 18 shows the responses when the respondents were asked if they saw DMS displaying information that describes travel time about "Orlando International Airport," how they would interpret it as. The answers were "The travel time is the amount of time it takes to get to the airport exit," or "The travel time is the amount of time it takes to get to the airport terminal." 54.2% of the travelers responded that it is the time to the airport exit. This would actually be the correct interpretation if the OOCEA were to display travel time to this airport. Therefore, 45.8% of the respondents would not have correctly interpreted the information given to them.

Table 18: Perception of Travel Time to "Orlando International Airport" (Q29)

Variable	Frequency	Percent (%)
A) Airport Exit	**813**	**54.2%**
B) Airport Terminal	687	45.8%
# of Respondents Who Answered Q29	1500	100.0%

4.6 Revealed Diversion (Pre Q21/Post Q28) & Stated Diversion (Pre Q22/Post Q31)

For the following section of results on RP to diversion from pre-deployment survey question 21 and post-deployment survey question 28, only people who responded to pre-deployment survey question 23A or post-deployment survey question 26 “How much time did you expect it to add to your trip?” as “20-30 minutes” and “Over 30 minutes” were compared to the results of the SP diversion question. While this is not as comparing apples to apples, it is somewhat close. If a person responded to pre-deployment survey questions 21 or 22 and post-deployment questions 28 or 31 with “a) Stayed on the toll road and waited it out” then this was classified as “Stayed” on the route, while other responses including “b), c), or d)” were classified as “Diverted” from the route. It should be noted that for the pre-deployment survey, only the responses to survey version 14A (sample size n = 500) were used for these results. Table 19 shows the number of respondents who answered either “Stayed” or “Diverted” to each of these questions.

Table 19: Comparison of RP and SP for Pre and Post-Deployment Survey Results

Pre-Deployment Results			
	Stayed	**Diverted**	**Total**
Q21 (RP)	56	39	95
	58.95%	41.05%	100.00%
Q22 (SP)	34	61	95
	35.79%	64.21%	100.00%
Post-Deployment Results			
	Stayed	**Diverted**	**Total**
Q28 (RP)	126	88	214
	58.88%	41.12%	100.00%
Q31 (SP)	57	157	214
	26.64%	73.36%	100.00%

Even though for the pre-deployment survey there were a total of 255 respondents who were asked question 21, and 500 respondents who were asked question 22, for this comparison, 95 responses could be compared. Similarly, for the post-deployment survey there were a total of 732 respondents who were asked question 28, and 1500 respondents who were asked question 31, for this comparison, 214 responses could be compared. The responses for the RP diversion question, are of those respondents who expected the delay that they actually experienced to be 30 minutes or more. So, the SP diversion question asks what they would do if facing 30 minutes of delay. The results for the RP diversion question showed that for the pre-deployment survey 41.05% of the respondents diverted off the toll road, and the results of the post-deployment survey showed that 41.12% of the respondents diverted off the toll road. This shows a similar result for both the pre and post-deployment surveys. The results for the SP diversion question showed that for the pre-deployment survey 64.21% of the respondents diverted off the toll road, and the results of the post-deployment survey showed that 73.36% of the respondents diverted off the toll road. This shows an increase of nearly 10% of the respondents who are stating that they would divert off of the toll road in the presence of a 30-minute delay.

Below, Table 17 shows the number of respondents who agreed or disagreed in their responses towards the SP and RP diversion. From observing Table 20 below, for the pre-deployment survey 44.21% of the respondents showed conflicting statements when comparing RP and SP, while 55.79% of the respondents showed agreement. For the post-deployment survey 41.59% of the respondents showed conflicting statements when comparing RP and SP, while 58.41% of the respondents showed agreement. This shows that for the post-deployment survey, a larger percentage of the respondents showed agreement between the RP and SP diversion behavior. The difference between RP and SP diversion behavior is that RP is the actual past diversion. This is the respondents' commented past behavior to divert. SP is more like the respondent's motivation because in real situations as in RP respondents may be stuck between exits where they have no choice but to stay. Even though SP is a fictitious situation, examining the responses is beneficial because it shows overall drivers' propensity to divert.

Table 20: RP & SP Response Agreement and Contradiction for Pre and Post-Deployment

Pre-Deployment Results					
	Stayed & Stayed	**Stayed & Diverted**	**Diverted & Stayed**	**Diverted & Diverted**	**Total**
Q21 (RP) & Q22 (SP)	24	32	10	29	95
	25.26%	33.68%	10.53%	30.53%	100.00%
Negative					44.21%
Positive					55.79%
Post-Deployment Results					
	Stayed & Stayed	**Stayed & Diverted**	**Diverted & Stayed**	**Diverted & Diverted**	**Total**
Q21 (RP) & Q22 (SP)	47	79	10	78	214
	21.96%	36.92%	4.67%	36.45%	100.00%
Negative					41.59%
Positive					58.41%

The following tables are from the full combined 1500 survey results for Pre and Post-Deployment surveys, excluding those not qualified

Table 21 below shows the results of pre-deployment question 20 and post-deployment question 22. From the table it can be seen that for both the pre and post-deployment survey results, the response "Accident" had the highest frequency of the cause of congestion with 64.70% for pre-deployment and 61.75% for post-deployment. This showed a much higher frequency than any other response with "Construction/road work" as the second highest response.

Table 21: Cause of Unexpected Congestion from RP (Pre Q20/Post Q22)

Pre-Deployment Results		
Variable	**Frequecy**	**Percentage (%)**
A) Accident	476	64.70%
B) Disabled Vehicle	22	3.00%
C) Construction/road work	142	19.30%
D) Weather related	11	1.50%
E) Other	51	6.90%
F) Don't know	34	4.60%
# of Responses	736	100.00%
Post-Deployment Results		
Variable	**Frequecy**	**Percentage (%)**
A) Accident	452	61.75%
B) Disabled Vehicle	32	4.37%
C) Construction/road work	140	19.13%
D) Weather related	8	1.09%
E) Other	68	9.29%
F) Don't know	32	4.37%
# of Responses	732	100.00%

Observing Table 22 below, pre-deployment question 24 was asked to everyone who in both/either questions 21 and 22 responded that they "Stayed." Also, it should be noted that for the post-deployment survey results only the respondents who responded to post-deployment question 28 as "Stayed" were asked post-deployment question 30. For the pre and post-deployment results, the answer "It would be faster to stay on the toll road" had the highest percentage with 35.4% for pre-deployment and 27.05% for post-deployment. It is probably understood by these travelers that the toll roads are generally a more efficient means of travel even under unfriendly circumstances. The added response for the post-deployment survey "Stuck between exits and not able to exit" gave the respondents of the post-deployment survey another way to respond and it showed to be the second highest response rate. This shows that while the travelers may want to exit the toll road, they may not be able to since they are stuck between exits. It is also beneficial to note that the response "Unfamiliar with alternate routes" has shown a lower percentage in the post-deployment results, this shows that the travelers are becoming more aware of the alternate routes and may be more likely to divert in the future.

Table 22: Main Reason to Stay on the Toll Road and Wait it out (Pre Q24/Post Q30)

Pre-Deployment Results		
Variable	**Frequecy**	**Percentage (%)**
A) Unfamiliar with alternate routes	139	21.40%
B) Do not trust travel time information	8	1.20%
C) It would be faster to stay on the toll road	230	35.40%
D) Combination of any of the above	162	24.90%
E) None of the above	111	17.10%
# of Responses	650	100.00%
Post-Deployment Results		
Variable	**Frequecy**	**Percentage (%)**
A) Unfamiliar with alternate routes	73	13.90%
B) Do not trust travel time information	3	0.57%
C) It would be faster to stay on the toll road	142	27.05%
D) Stuck between exits and not able to exit	131	24.95%
D) Combination of any of the above	116	22.10%
E) None of the above	60	11.43%
# of Responses	525	100.00%

The following Table 23 discusses the issue of if travelers have seen abnormally high travel times displayed on DMS on the OOCEA toll road network. This question was only asked during the post-deployment survey and was limited to only the people that had prior knowledge of DMS. As you can see from the results, 42.65% of the respondents recalled seeing abnormal travel times displayed on DMS.

Table 23: Have You Seen Abnormal Travel Times Displayed on DMS

Variable	Frequency	Percentage
Yes	409	42.65%
No	550	57.35%

If the respondent answered that they had seen abnormal travel times displayed on DMS, they were then asked if they diverted off the toll road in response to the abnormal travel time. The following Table 24 shows the results of the traveler's response to the abnormal travel time. From the results it can be seen that 49.14% of the travelers stated they diverted when facing abnormal travel times displayed on DMS.

Table 24: Did You Divert Off the Toll Road in Response to the Abnormal Travel Time

Variable	Frequency	Percentage
Yes	201	49.14%
No	208	50.86%

If the respondent answered that they would not divert in response to the abnormal travel times displayed on DMS, they were then asked what the reason would be for not diverting off the toll road. The following Table 25 shows the results of why the traveler would not divert off the toll road in response to the abnormal travel time.

Table 25: Main Reason to Stay on the Toll Road in Case of Abnormal Travel Time

Variable	Frequency	Percentage
A.) Unfamiliar with alternate routes	36	17.31%
B.) Do not trust accuracy of travel time information	17	8.17%
C.) Combination of A.) and B.)	51	24.52%
D.) None of the above	104	50.00%

4.7 Pre-Modeling Correlations of Pre and Post-Deployment Survey Questions

4.7.1 Theoretical Background

In the analysis of surveys, the emphasis is on the characteristics and preferences of the OOCEA travelers that are measured by qualitative variables. In these cases, the frequency counts of the variables provide important information about the distribution of the characteristics and / or preferences of the commuters. As was explained in the previous section, the mode is an important univariate measure of central tendency for qualitative variables. However, in addition to univariate analysis, bi-variate analyses need to be performed to gauge the relationships between sets of variables. Contingency tables are used to compare two variables with one another. On the following page, the Table 26 shown is an example of a contingency table comparing the County, and (Q2) “Most used toll road”. It is to be noted that these questions were taken from the pre-deployment survey results.

Table 26: Contingency Table of SR and County (Pre-Deployment Survey)

Table of (Q2 "SR") by County				
(Q2 "SR") (Respondents)	**County (Respondents)**			
Frequency Percent Row Pct Col Pct	**ORANGE**	**OSCEOLA**	**SEMINOLE**	**Total**
SR 408	321 21.40% 61.26% 61.85%	75 5.00% 14.31% 15.63%	128 8.53% 24.43% 25.55%	524 34.93%
SR 417	83 5.53% 11.48% 15.99%	311 20.73% 43.02% 64.79%	329 21.93% 45.50% 65.67%	723 48.20%
SR 429	48 3.20% 52.75% 9.25%	17 1.13% 18.68% 3.54 %	26 1.73% 28.57% 5.19%	91 6.07%
SR 528	67 4.47% 41.36% 12.91 %	77 5.13% 47.53% 16.04 %	18 1.20% 11.11% 3.59%	162 10.80%
Total	519 34.60%	480 32.00%	501 33.40%	1500 100.00%

To model the relationships between two variables, it is needed to check for dependency or association between them. In the case of qualitative variables, the measures of association are calculated using the number of occurrences (counts) for a combination of levels of different variables. Observing Table 27, the counts for each combination of levels form the contingency table, with r rows corresponding to r levels of variable (or r possible responses to a specific question in the survey) and c columns corresponding to c levels of another variable (responses to a different question). This is referred to as an r X c contingency table. For two variables with r and c levels respectively, the contingency table is referred to as a two-way r X c contingency table. For three variables with *r*, *c*, and *p* levels respectively, the contingency table is referred to as three-way *r* X *c* X *p* table, and so forth.

i = level of variable 1 = 1, 2,…,r

j = level of variable 2 = 1, 2,…,c

xij = number of occurrences (observed frequency) of variable 1 at level *i* and variable 2 at level *j*

cell (i,j) = cell in the contingency table corresponding to level shows a simple two-way contingency table.

Table 27: A Representation of a Simple Two-Way Contingency Table

		Variable 2 (m levels)					
		1	2	…	J	…	C
Variable 1 (n levels)	1	x_{11}	x_{12}				ΣX_{1c}
	2	x_{21}	x_{22}				ΣX_{2c}
	…						
	I	x_{i1}	x_{i2}	…	x_{ij}	…	ΣX_{ic}
	…						
	R	ΣX_{r1}	ΣX_{r2}				ΣX_{rc}

i = level of variable 1 = 1, 2,…,r

j = level of variable 2 = 1, 2,…,c

xij = number of occurrences (observed frequency) of variable 1 at level *i* and variable 2 at level *j*

cell (i,j) = cell in the contingency table corresponding to level

Contingency tables can be used to check the assumption of whether two qualitative variables are associated with each other or not. If two variables are independent, then the expected frequencies in each cell of the table (corresponding to each level of the variables 1 and 2) should be the same as the observed frequencies. The expected frequencies of each cell (i,j) are calculated as in Equation 2:

$(\text{column total of column j/grand total}) \times$ row total of row i

$$\bar{E}_{ij} = \left(\frac{\left(\sum_{i=1}^{r} x_{ij}\right)\left(\sum_{j=1}^{r} x_{ij}\right)}{\sum_{i=1}^{r}\sum_{j=1}^{c} x_{ij}} \right)$$

where $\bar{E}_{ij}$ is the expected count for cell (i,j) in the contingency table.

Equation 2: Expected Frequency Count for Cell

By examining the difference between $\bar{E}_{ij}$ and x_{ij} for all cells, it is possible to hypothesize if the difference is purely due to chance or if it is due to an underlying relationship between variable 1 and variable 2. This is achieved by the Chi-square test for independence.

Chi-square test for independence is used to assess the probability that a relationship between two variables is due to chance. This is done by measuring the squares of deviations between the observed frequencies in each cell of a table and the expected frequencies normalized by the expected frequencies. The larger these differences are, the less likely it is that they occurred by chance. A statistic is derived from this, known as the chi-square statistic, which can be compared to a theoretical chi-square distribution identified by the degrees of freedom (*df*). For a two-way contingency table with r rows and c columns, the *df* for comparison with the theoretical chi-square is (r-1) (c-1). The whole description can be formulated as in Equation 3:

test statistic $\chi^2 = \sum_{i,j} \frac{(\bar{E}_{ij} - x_{ij})^2}{\bar{E}_{ij}}$

(Null hypothesis) H_0: The variables are independent

(Alternate hypothesis) H_a: The variables are not independent

Equation 3: Chi-squared Test Statistic

If χ^2 is large enough (corresponding to a very low significance level or p-value), when compared to a standard chi-square χ^2 distribution with (degrees of freedom) *df*= (r-1) (c-1), then the null hypothesis can be rejected. This shows that there is not sufficient evidence to show that the variables are independent. This implies that the variables could be associated.

The chi-squares test for independence is a standard test for detecting the presence of association among qualitative variables. However, the test by itself cannot indicate the strength of relationship between variables. It does indicate pointers to the researchers and practitioners with enough domain knowledge to identify related variables and draw useful conclusions regarding the relationship and causality between variables. It must be noted that chi-square test by itself does not indicate causality.

The chi-squares test is also an important pre-modeling technique in identifying related factors / variables that could cause multi-collinearity in various regression models. Multi-collinearity is a problem in statistical regression modeling due to redundancy caused by correlated variables. This leads to the estimates of the parameters having high standard errors with a dubious strength in the model. Such a model will not be useful as the conclusions are misleading. Since objectives of this thesis include modeling the satisfaction of the commuters with traffic information on toll roads as well as their diversion behavior, the chi-squares test is an important precursor in identifying redundant variables in modeling. However, stronger measures of association are required to identify potentially correlated variables.

Cramer’s V is a measure that is derived from the chi-square test statistic that is analogous to correlation coefficient in the case of continuous variables. It varies between 0 and 1, and higher values indicate a stronger relationship between the levels of the variable. Cramer’s V is formulated as below in Equation 4:

$$V = \sqrt{\frac{\chi^2}{nm}}$$

where n = sample size,

m= smaller of (r-1, c-1)

where r = number of rows, c = number of columns

Equation 4: Cramer’s V Statistic

Table 28 (51) shows the strength of association between two variables on the basis of the different possible Cramer’s V values.

Table 28: Strength of Association as Given by a Range of Cramer's V Values

Correlation value	Verbal designation of the strength of relationship
0	No relationship
0.01 - 0.1	Very weak
0.11-0.25	Weak
0.26-0.50	Moderate
0.51-0.75	Strong
0.76-0.99	Very Strong
1	Perfect association

Therefore, if two variables show a relationship that is at least as strong as “Moderate” or stronger, then the variables are deemed to be correlated. These variables should not enter a regression model together as they will induce redundancy and multi-collinearity that would render the model misleading and un-interpretable.

4.7.2 Pre-Deployment Contingency Table Results

The following Table 29 summarizes the number of correlations each pre-deployment survey question has with another. Question 11 had the most number of correlations, and this subject is “DMS improve travel experience.” The satisfaction questions all in general Q9, Q11-15, and Q26 have more than one correlation.

Table 29: Summary of the Number of Correlations for Pre-Deployment

Question	# of Correlation(s)
Q2 Most used OOCEA toll road	1
Q3 Number of trips a week	1
Q4 Trip purpose	1
Q9 Satisfaction about traveler information	4
Q10 Recall seeing DMS on toll road	1
Q11 DMS improve travel experience	6
Q12 DMS helpful in informing about hazards	4
Q13 DMS helpful in giving special event information	3
Q14 Easy to read DMS while driving	3
Q15 Travel time on DMS is accurate	4
Q20 How first learned of unexpected congestion	1
Q21 Response to unexpected congestion	1
Q22 Suppose 30 minutes of unexpected congestion	1
Q26 DMS have helped you save time	4

In the following page, from Table 30, which shows the strength of association between two variables, the strongest correlation found was between Q11 “DMS improve travel experience” and Q12 “DMS was helpful in informing travelers about hazards.” This means a significant amount of responses from Q11 are associated with Q12. The other correlations listed are only the moderate ones. Most of the satisfaction questions Q9, Q11, Q12, Q13, Q14, Q15, and Q26 are moderately correlated. Q2 “Most Used Toll Road” and “County” are moderately correlated. Q21 “RP Diversion Behavior” and Q22 “SP Diversion Behavior” are also moderately correlated. The correlation between variables is a starting point in modeling.

Table 30: Cramer's V and Chi-Square P-Values for Pre-Deployment

Correlation	Cramer's V	Chi-Sq P-value	Question by	Question
Moderate	0.362909	0.0001	Q2 Most used toll road	County
Moderate	0.292322	7.09778E-75	Q3 Number trip a week	Q4 Trip purpose
Moderate	0.301479	6.24229E-43	Q9 Satisfaction about traveler information	Q11 DMS improve travel experience
Moderate	0.3053	3.98843E-44	Q9 Satisfaction about traveler information	Q12 DMS helpful in informing about hazards
Moderate	0.306342	1.87253E-44	Q9 Satisfaction about traveler information	Q15 Travel time on DMS accurate
Moderate	0.27739	9.06031E-36	Q9 Satisfaction about traveler information	Q26 DMS have helped you save time
Moderate	0.31872	2.23463E-15	Q10 Recall seeing DMS on toll road	Q20 How first learned of unexpected congestion
Strong	**0.543798**	**4.9907E-150**	**Q11 DMS improve travel experience**	**Q12 DMS helpful in informing about hazards**
Moderate	0.350988	1.20958E-59	Q11 DMS improve travel experience	Q13 DMS helpful in giving special event information
Moderate	0.287032	1.46932E-38	Q11 DMS improve travel experience	Q14 Easy to read DMS while driving
Moderate	0.359911	6.11532E-63	Q11 DMS improve travel experience	Q15 Travel time on DMS accurate
Moderate	0.39132	3.13795E-75	Q11 DMS improve travel experience	Q26 DMS have helped you save time
Moderate	0.416298	9.12698E-86	Q12 DMS helpful in informing about hazards	Q13 DMS helpful in giving special event information
Moderate	0.329322	5.31412E-52	Q12 DMS helpful in informing about hazards	Q14 Easy to read DMS while driving
Moderate	0.319084	1.44174E-48	Q13 DMS helpful in giving special event information	Q26 DMS have helped you save time
Moderate	0.314408	4.88911E-47	Q14 Easy to read DMS while driving	Q15 Travel time on DMS accurate
Moderate	0.326997	3.27524E-51	Q15 Travel time on DMS accurate	Q26 DMS have helped you save time
Moderate	0.280785	1.1669E-09	Q21 RP Diversion	Q22 SP Diversion

4.7.3 Post-Deployment Contingency Table Results

The following Table 31 summarizes the number of correlations each question has with another. Question 13 and 14, do DMS improve travel experience and are DMS helpful for hazard warnings, had the most number of correlations. As with the pre-deployment results, all of the satisfaction questions (Q11, Q13-17 and Q33) have multiple correlations.

Table 31: Summary of the Number of Correlations for Post-Deployment

Question	# of Correlation(s)
Q2 - Most frequently used toll road	3
Q3 - Number of one-way trips	1
Q4 - Main purpose of trip	1
Q5 - One way travel time on the toll road	1
Q7 - One way travel time on the alternate toll road	1
Q11 - Satisfaction with traffic information	3
Q12 - Awareness of DMS on toll roads	1
Q13 - Do DMS make travel more pleasant	7
Q14 - Are DMS helpful in hazard warnings	7
Q15 - Are DMS helpful for special event info	6
Q16 - Are DMS easy to read	4
Q17 - Are DMS accurate	6
Q20 - Why did you divert from the toll road due to abnormal travel times	1
Q23 - How did you learn about congestion on toll road	2
Q24 - What toll road did you experience the congestion on	3
Q25 - What direction did you experience the congestion	3
Q29 - Did a DMS sign help you in your decision	1
Q30 - Why did you stay on toll road	1
Q33 - Do you agree that DMS helped you save travel time	5
Q34 - format - SR436 Vs Semoran	3
Q35 - format - SR426 Vs Aloma	2
Q36 - format - SR434 Vs Alafaya	3
Q37 - Do you want DMS to inform you of abnormal traffic situation	4
Q39 – Age	2
Q40 - Education level	2
Q41 - Length of residency	2

In the following page, from Table 32, which shows the strength of association between two variables, the strongest correlation found was between Q24 “What toll road did you experience the congestion on” and Q25 “What direction did you experience the congestion on”. This result is to be expected because which direction you are traveling on depends on which toll road you are traveling on, so if this result is neglected then the strongest correlation is between Q13 “Do DMS improve travel experience” and Q14 “Are DMS helpful for hazard warnings”. This means a significant amount of responses from Q13 are associated with Q14. The other correlations listed are only the moderate ones. Most of the satisfaction questions Q11, Q13-17, and Q33 are moderately correlated. Q28 “RP Diversion Behavior” and Q31 “SP Diversion Behavior” were not moderately correlated as shown in the pre-deployment survey analysis.

Table 32: Cramer's V and Chi-Square P-Values for Post-Deployment

Correlation	Cramer's V	Chi-Sq P-value	Question by	Question
Moderate	0.383459309	3.99299E-92	County	Q2 - Most frequently used toll road
Moderate	0.278821975	3.23742E-22	County	Q24 - What toll road did you experience the congestion on
Moderate	0.305931343	4.25895E-27	County	Q25 - What direction did you experience the congestion
Moderate	0.283836155	1.67198E-17	County	Q34 - format - SR436 Vs Semoran
Moderate	0.289634658	3.39439E-18	County	Q36 - format - SR434 Vs Alafaya
Moderate	0.272086513	2.16856E-30	Q2 - Most frequently used toll road	Q24 - What toll road did you experience the congestion on
Moderate	0.295725097	8.82284E-77	Q3 - Number of one-way trips	Q4 - Main purpose of trip
Moderate	0.348543368	5.0986E-128	Q5 - One way travel time on the toll road	Q7 - One way travel time on the alternate toll road
Moderate	0.300558477	8.10659E-51	Q11 - Satisfaction with traffic information	Q13 - Do DMS make travel more pleasant
Moderate	0.288916659	1.19394E-46	Q11 - Satisfaction with traffic information	Q14 - Are DMS helpful in hazard warnings
Moderate	0.312529727	2.76378E-55	Q11 - Satisfaction with traffic information	Q17 - Are DMS accurate
Moderate	0.351992371	9.37806E-19	Q12 - Awareness of DMS on toll roads	Q23 - How did you learn about congestion on toll road
Strong	**0.565669574**	**2.2649E-192**	**Q13 - Do DMS make travel more pleasant**	**Q14 - Are DMS helpful in hazard warnings**
Moderate	0.438112008	3.7252E-113	Q13 - Do DMS make travel more pleasant	Q15 - Are DMS helpful for special event info
Moderate	0.295227134	6.90592E-49	Q13 - Do DMS make travel more pleasant	Q16 - Are DMS easy to read
Moderate	0.314447767	5.11313E-56	Q13 - Do DMS make travel more pleasant	Q17 - Are DMS accurate
Moderate	0.403827394	2.27857E-95	Q13 - Do DMS make travel more pleasant	Q33 - Do you agree that DMS helped you save travel time

Correlation	Cramer's V	Chi-Sq P-value	Question by	Question
Moderate	0.328642594	2.64297E-22	Q13 - Do DMS make travel more pleasant	Q37 - Do you want DMS to inform you of abnormal trafic situation
Moderate	0.454389033	4.0365E-122	Q14 - Are DMS helpful in hazard warnings	Q15 - Are DMS helpful for special event info
Moderate	0.329243502	7.9002E-62	Q14 - Are DMS helpful in hazard warnings	Q16 - Are DMS easy to read
Moderate	0.342078078	4.26966E-67	Q14 - Are DMS helpful in hazard warnings	Q17 - Are DMS accurate
Moderate	0.411697587	2.5489E-99	Q14 - Are DMS helpful in hazard warnings	Q33 - Do you agree that DMS helped you save travel time
Moderate	0.398582896	8.18056E-33	Q14 - Are DMS helpful in hazard warnings	Q37 - Do you want DMS to inform you of abnormal trafic situation
Moderate	0.296028228	3.56031E-49	Q15 - Are DMS helpful for special event info	Q16 - Are DMS easy to read
Moderate	0.319767251	4.48405E-58	Q15 - Are DMS helpful for special event info	Q17 - Are DMS accurate
Moderate	0.367102651	5.71131E-78	Q15 - Are DMS helpful for special event info	Q33 - Do you agree that DMS helped you save travel time
Moderate	0.265147278	1.52206E-14	Q15 - Are DMS helpful for special event info	Q37 - Do you want DMS to inform you of abnormal trafic situation
Moderate	0.338970941	8.4106E-66	Q16 - Are DMS easy to read	Q17 - Are DMS accurate
Moderate	0.270108652	2.77157E-40	Q17 - Are DMS accurate	Q33 - Do you agree that DMS helped you save travel time
Moderate	0.250823458	0.000612841	Q19 - Did you divert from toll road due to abnormal travel time on DMS	Q28 - What did you do in response to congestion
Moderate	0.402315135	2.96492E-05	Q20 - Why did you divert from the toll road due to abnormal travel times	Q30 - Why did you stay on toll road
Moderate	0.4836748	1.68042E-26	Q23 - How did you learn about congestion on toll road	Q29 - Did a DMS sign help you in your decision

Correlation	Cramer's V	Chi-Sq P-value	Question by	Question
Strong	**0.578394164**	**2.4495E-152**	**Q24 - What toll road did you experience the congestion on**	**Q25 - What direction did you experience the congestion**
Moderate	0.28960297	2.48049E-17	Q33 - Do you agree that DMS helped you save travel time	Q37 - Do you want DMS to inform you of abnormal trafic situation
Moderate	0.27379129	2.27737E-17	Q34 - format - SR436 Vs Semoran	Q35 - format - SR426 Vs Aloma
Moderate	0.388955408	2.05916E-33	Q35 - format - SR436 Vs Semoran	Q36 - format - SR434 Vs Alafaya
Moderate	0.435536285	1.85106E-41	Q35 - format - SR426 Vs Aloma	Q36 - format - SR434 Vs Alafaya
Moderate	0.28887974	4.6597E-116	Q39 - Age	Q40 - Education level
Moderate	0.349518837	3.3121E-177	Q39 - Age	Q41 - Length of residency
Moderate	0.314102756	5.401E-140	Q40 - Education level	Q41 - Length of residency

CHAPTER FIVE: MODELING RESULTS

5.1 Choice Modeling

5.1.1 Theoretical Background

The next objective of this research is two-fold:

1. To model and compare the pre and post-deployment overall satisfaction of the OOCEA commuters with the traffic information on toll roads with emphasis on the source of traffic information, specifically on the DMS.
2. To model and compare the pre and post-deployment diversion behavior of the OOCEA commuters when faced with real-life, unexpected delays and congestion, and the role of DMS in this behavior.

The goal of the first objective of modeling is to predict and compare the likelihood of satisfaction of OOCEA commuters with the traffic information on the toll roads with respect to their demographic and trip characteristics, and importantly, the perceptions of the travelers with respect to different aspects of the DMS. Such a model formulation would show the significant demographic and trip characteristics of the individuals that are likely to influence their satisfaction level towards traffic information and their expectations for an effective traveler information system. As a result, it will be easy to see if the DMS meet their expectations as an effective traveler information system. Such a model can be fit to both pre and post-deployment surveys so that we can compare how the public perceives the benefits from the DMS over a period of increasing exposure to DMS.

The goal of the second objective of modeling is to show and compare how DMS are utilized in real-time situations. When faced with unexpected delays with insufficient or uncertain information, the travelers are likely to be confused about the "right" decision to be taken. More often, the right decision is circumstantial and the travelers make subjective decisions. While the DMS on OOCEA toll road network do not usually provide messages that direct the actions of the travelers (except in special circumstances), it is required to know whether (or not) the DMS ease the decision making process for the travelers by providing reliable information. Modeling RP to diversion (what the travelers actually did in the field in response to unexpected delays) helps to analyze the effect the DMS have had in easing the decision process for the individual travelers in the face of unexpected delays. As with the satisfaction model, such a model can be fit to both pre and post-deployment surveys so that we can compare how the public perceives the benefits from the DMS over a period of increasing exposure to DMS.

The basis of the choice modeling is the logit model. Ordinary regression is used to model the relationship between a continuous dependent variable *y* and continuous / qualitative predictor variables $x_1, x_2, \ldots, x_n$. When *y* is a qualitative variable, ordinary least squares regression violates certain assumptions and becomes difficult to interpret. In such situations, binary logit or probit models are appropriate. The binary logit model is represented as the following in Equation 5:

$$Logit(p(y=1)) = \ln\left(\frac{p_{(y=1)}}{1-p_{(y=1)}}\right) = \beta_0 + \beta_1 x_1 + \cdots + \beta_n x_n$$

Where y=1: the targeted dependent is a success (binary y=0,1).

p(y=1) is the probability of occurrence / 1-p(y=1) is the probability of non-occurrence.

ln $p(y=1)/(1-p(y=1))$ is the natural logarithm of the odds of target for variable *y*.

β_0 is the estimated constant, $\beta_{1\ldots}$ β_n are the coefficients for each independent variable x (n=total number of independent variables)

$Logit(p(y=1))$ is the probability of the targeted event occurring

Equation 5: Binary Logit Model

Therefore, in the data that is to be used in modeling, if the dependent variable is binary with two categories, the outcome can be coded as 1 and the other outcome as 0. The predictor variables can be the characteristics of the individuals and / or the characteristics of the alternatives. This is known as the binary logit model.

5.1.2 Interpretation of Coefficients

The coefficients for the predictor variables in the binary logit model are the increase (or decrease) in the log odds for the outcome $y=1$ with respect to $y=0$. For continuous or ordinal predictor variables, a positive value corresponds to the increase in log odds for one unit increase in the predictor variable, when all the other predictors are held constant. In simple terms, a significant positive coefficient implies that the outcome that is being modeled increases the likelihood of occurrence than the base case for that particular predictor. A negative coefficient implies that the modeled outcome decreases the likelihood of occurrence than the base case for the particular predictor.

5.2 Logit Model for Satisfaction

5.2.1 Theoretical Variable Selection

To begin the modeling of satisfaction with traffic information acquired from DMS, pre-deployment question (Q9) and post-deployment question (Q11) are targeted along with 15 independent variables thought to be theoretically significant. Only the survey responses indicating knowledge of DMS (yes to pre-deployment Q10 and post-deployment Q12) were used in the satisfaction analysis (816 pre-deployment responses and 959 post-deployment responses).

Using the results of both the DMS pre and post-deployment surveys, the results of pre-deployment Q9 and post-deployment Q11 (Satisfaction with traveler information provided on the toll roads) are modeled as a binary variable as shown below:

1 = Success (Strongly Agree or Agree)

0 = Failure (Disagree or Strongly Disagree)

Originally 15 important explanatory variables that seemed theoretically relevant for explaining the propensity of the commuters to be satisfied were selected during the pre-deployment survey. For the sake of comparison, these same variables will be used for both pre and post-deployment models to show a comparison between the two survey results. These important explanatory variables are shown in Table 33:

Table 33: Important Explanatory Variables for Modeling Satisfaction (Pre Q9/Post Q11)

Pre	Post	Variables	# of levels	Levels of Explanatory Variables
-	-	County	3	Orange, Seminole, Osceola
Q2	Q2	Most traveled toll road	4	SR 408, SR 417, SR 429, SR 528
Q3	Q3	Number of trips on the most traveld toll road	4	<1, 1-5, 6-10, >10
Q4	Q4	Main purpose of the most frequent trips	5	Work, Shopping, School, Recreational, Other
Q5	Q6	Number of alternate routes known	5	None, 1, 2, 3, 4 or more
Q8	Q10	Acquistion of traffic information	5	DMS, Radio, 511, Other, None
Q11	Q13	DMS improve traveling experience on toll roads	4	Strongly Agree, Agree, Disagree, Strongly Disagree
Q12	Q14	DMS helpful with hazard warnings	4	Strongly Agree, Agree, Disagree, Strongly Disagree
Q13	Q15	DMS helpful for special event infromation	4	Strongly Agree, Agree, Disagree, Strongly Disagree
Q14	Q16	DMS easy to read while driving	4	Strongly Agree, Agree, Disagree, Strongly Disagree
Q15	Q17	DMS accurate with travel times	4	Strongly Agree, Agree, Disagree, Strongly Disagree
Q25	Q32	How did DMS help you reschedule your travel	5	Adding unintended intermediate stops, Canceling intended intermediate stops, Inform someone you are running late, Other, Did not help
Q26	Q33	Did DMS save you time	4	Strongly Agree, Agree, Disagree, Strongly Disagree
Q30	Q39	Age	5	18-25, 26-35, 36-50, 51-65, 65+
Q31	Q40	Education Level	5	High School Diploma or Less, Some College, Associate Degree, Bachelor Degree, Post Graduate Degree

5.2.2 A Priori Expectations for the Explanatory Variables for Pre and Post-Deployment Overall Satisfaction

The following Table 34 summarizes the a priori expectations for the explanatory variables for the comparison between the pre and post-deployment satisfaction models.

Table 34: A Priori Expectations for the Effect of Explanatory Variables for Satisfaction

Pre	Post	Variable	A Priori Expectations for the Explanatory Variables for Pre and Post-Deployment Survey	Is Change Expected between Pre and Post Deployment Survey
-	-	County	OOCEA toll roads are in Orange County. *Orange County residents might have a different attitude towards DMS than residents of Seminole or Osceola Counties.*	Yes - DMS deployed in part in Seminole and Osceola counties in post deployment
Q2	Q2	Most traveled toll road	SR 408 is the most congested, and had the only DMS located on it in the pre-deployment period. *SR 408 travelers might have different attitude towards DMS than SR 417, SR 429 or SR 528*.	Yes - DMS deployed on all four toll roads in post deployment
Q3	Q3	Number of trips on the most traveled toll road	*Frequency of travel* might influence travelers' familiarity with the toll road, and therefore, influence them differently towards DMS.	Yes - In post deployment, the travelers are more likely to see DMS with increased number of trips
Q4	Q4	Main purpose of the most frequent trips	Work and School trips are bound by tighter time constraints than Shopping and Recreational trips. Travelers with *Work and School purposes might have different attitudes towards DMS.*	Yes - In post deployment, the travelers are more likely to see DMS with regular trips associated with Work and School
Q5	Q6	Number of alternate routes known	As number of alternate routes known increases, familiarity of the traveler with the network increases. *Higher familiarity could be associated with the travelers' expectations for more information*.	No
Q8	Q10	Acquisition of traffic Information	The source of traveler information could influence the travelers' satisfaction with information. *The OOCEA is optimistic that DMS would be associated with higher traveler satisfaction.*	Yes - In post deployment, customers are more likely to rely on DMS
Q11	Q13	Do DMS improve traveling experience on toll roads?	If travelers are *satisfied with their travel experience with DMS* on toll roads, it is likely that their overall satisfaction improves	Yes - In post deployment, travelers expectations of pleasant travel experience could increase

Pre	Post	Variable	A Priori Expectations for the Explanatory Variables for Pre and Post-Deployment Survey	Is Change Expected between Pre and Post Deployment Survey
Q12	Q14	Are DMS helpful for giving warnings about hazards on toll roads?	If travelers are *satisfied with hazard warning messages on DMS* on toll roads, it is likely that their overall satisfaction improves.	Yes - In post deployment, with multiple DMS installed, travelers might give higher priority to hazard warnings on DMS
Q13	Q15	Are DMS helpful for giving special event information?	If travelers are *satisfied with special event information on DMS* on toll roads, it is likely that their overall satisfaction improves.	Yes - In post deployment, with multiple DMS installed, travelers might give higher priority to special event warnings on DMS
Q14	Q16	Are DMS easy to read while driving?	If travelers are *satisfied with readability of messages on DMS* on toll roads, it is likely that their overall satisfaction improves.	Yes - In post deployment, with multiple DMS installed, travelers might get used to DMS messages making them more comfortable with DMS
Q15	Q17	Are DMS accurate with travel time?	If travelers are *satisfied with accuracy of information on DMS* on toll roads, it is likely that their overall satisfaction improves.	Yes - In post deployment, with multiple DMS installed, travelers might expect very consistently accurate messages on all DMS
Q25	Q32	How did DMS help you reschedule your travel?	If travelers feel that *DMS helped them to reschedule their trips* due to DMS on toll roads, it is likely that their overall satisfaction improves.	Yes - In post deployment, with multiple DMS installed, travelers might expect that all DMS help them in the case of an unexpected incident on the toll road
Q26	Q33	Did DMS save you time?	If travelers feel that *DMS on toll roads helped them save time*, it is likely that their overall satisfaction improves.	Yes - In post deployment, with multiple DMS installed, travelers expect that multiple DMS can save them more travel time than in the pre-deployment period
Q30	Q39	Age	The *age of the travelers* might influence their attitude towards DMS on toll roads.	Yes - Different age groups get accustomed to new technologies at different paces
Q31	Q40	Education Level	The *education level of the travelers* might influence their attitude towards DMS on toll roads.	Yes - Different education levels get accustomed to new technologies at different paces.

5.2.3 Comparison of Pre and Post-Deployment Overall Satisfaction Models

To compare between the pre deployment and post deployment, it is essential to make sure that the comparison is made across similar models with the same variables. In the pre-deployment survey, the variables that were thought to be theoretically relevant were listed. Some of these variables did not enter the final models as all levels of these variables were insignificant. However, to compare between pre and post deployment survey results, the models will be compared with all the variables thought to be theoretically justified as shown in Table 28.

In the post-deployment survey, some variables were added that were expected to aid in improving the models. These new variables cannot be used to compare pre and post deployment models as there would not be corresponding variables in the pre deployment model to compare to.

Before we can compare these two models for changes in effects of variables, it is required to see if the likelihood of being satisfied with traffic information is dependent on when the survey was conducted. To this effect, both the surveys are pooled to get one dataset (a total of 1775 responses), with an additional dummy variable for the time of deployment, named Post – coded as 0 for "Pre-Deployment" and 1 for "Post-Deployment".

A pooled model is created with the specification as described in Table 34, with the addition of another dummy variable – "deploy" variable. Upon further investigation of the model, many variables were found to be insignificant thus were removed from the model. The final model includes a total of 10 variables. A breakdown of the dependent variable is shown below, it is to be noted that the full 1500 responses were not all included, only the responses that showed knowledge of DMS were used for this model.

- Pre-Deployment (816 responses – 84.2% success and 15.8% failure)

- Post-Deployment (959 responses – 84.9% success and 15.1% failure)

This model is given in Table 35:

Table 35: Variables Theoretically Relevant and Significant for Modeling Satisfaction (Pooled Pre and Post-Deployment)

Pooled Variable	Coefficient	Standard Error	P-value
Constant	-0.61041091	0.2804354	0.0295
Pre of Post-Deployment Dummy Variable (Pre = 0, Post = 1)	-0.01623195	0.14840464	0.9129
Number of one way trips per week - Less than one a week	0.59134896	0.18442815	0.0013
Trip purpose - Work and School	-0.50346471	0.15673658	0.0013
Alternate routes known - Ordinal	-0.11389721	0.05860772	0.052
Acquisition of traffic information on toll roads - DMS	0.23432248	0.17351948	0.1769
DMS helpful in providing hazard warnings - Strongly Agree and Agree	1.14100069	0.20783925	0
DMS helpful in providing special event information - Strongly Agree and Agree	0.78073367	0.16349236	0
DMS display accurate travel time information - Strongly Agree and Agree	1.19390793	0.17568272	0
How did DMS help reschedule travel - Canceling intend intermediate stops	-1.18624933	0.34774722	0.0006
DMS help save time - Strongly Agree and Agree	0.39928472	0.1741495	0.0219

Log likelihood function	-623.4585	Restricted log likelihood	-763.6201
Chi squared	280.3234	Degrees of freedom	10
Prob[ChiSqd>value]=	0.0000000	Pseudo R-squared	0.18355
Correct prediction	86.64789%	Sample-Size	1775 (816 Pre/959 Post)

These results show that there is no statistical change between pre and post-deployment satisfaction based on these theoretically relevant variables. Thus, the likelihood of being satisfied with traffic information is not affected significantly by DMS deployment (as indicated by the surveys). Users seem more satisfied if they are infrequent users and travel for non-work/school purposes. Users seem less satisfied if they have higher network familiarity. DMS attributes associated with higher levels of customer satisfaction include acquisition of traffic information on toll roads (significant only at 80% confidence interval), provision of hazard warnings, provision of special event information, accuracy of travel time information and perception of time saving benefits. Also, if DMS helped to reschedule travel by having the traveler cancel intended intermediate stops, the user would be less likely to be satisfied with travel information.

The next step is to see if there is a significant change in the variables between the pre and post-deployment, by comparing the specification given in Table 34 for pre and post-deployment survey models.

To test for a significant change in the satisfaction model between the pre and post-deployment surveys a z-test will be used to test for significance. Using the same variables as used in the pooled data model, shown in Table 35, a model will be made for both the pre and post-deployment models. These models will then be compared by calculating the z-test statistics for the differences between each of the coefficients to show if there is a significant difference between the two models. The following Equation 6 will be used to find the z-test statistic:

$$Z - Statistic = \frac{\beta_{post} - \beta_{pre}}{SE_{pooled}}$$

Where:

$$\beta_{post} = Post - Deployment\ Coefficient$$

$$\beta_{pre} = Pre - Deployment\ Coefficient$$

$$SE_{pooled} = \sqrt{SE_{post}^2 + SE_{pre}^2}$$

$$SE_{post} = Post - Deployment\ Standard\ Error$$

$$SE_{pre} = Pre - Deployment\ Standard\ Error$$

Equation 6: Z-Statistic for Comparing Coefficients

The following Table 36 shows the results and coefficient comparisons of the models for the theoretically relevant variables used in modeling the pooled data for both the pre and post-deployment statistics.

Table 36: Coefficient Comparison between Pre and Post-Deployment Satisfaction Models

	Pre-Deployment			Post-Deployment						
Variable	Coefficient	Standard Error	P-value	Coefficient	Standard Error	P-value	Standard Error Pooled	Z-Test Statistic	P-value	Significant Difference
Constant	-0.6577248	0.40592305	0.1052	-0.4768516	0.36687857	0.1937	0.547150261	0.33057325	0.3707	NO
Number of one-way trips per week - Less than one per week	0.45984221	0.2706318	0.0893	0.77615526	0.2616519	0.003	0.376434972	0.84028604	0.2005	NO
Trip purpose – Work and School	-0.2834036	0.2406991	0.239	-0.635578	0.20925933	0.0024	0.31894439	-1.10418763	0.1357	NO
Alternate routes known – Ordinal	**-0.2741632**	**0.08980631**	**0.0023**	**-0.0087609**	**0.07793338**	**0.9105**	**0.118906623**	**2.23202336**	**0.0129**	**YES**
Acquisition of traffic information on toll roads - DMS	0.47283434	0.27535109	0.0859	0.10710606	0.22497876	0.634	0.355575119	-1.02855419	0.1515	NO
DMS helpful in providing hazard warnings - Strongly Agree and Agree	1.46233151	0.36110306	0.0001	1.04020394	0.27444262	0.0002	0.453557242	-0.93070407	0.1762	NO
DMS helpful in providing special event information - Strongly Agree and Agree	**0.25128839**	**0.24558295**	**0.3062**	**0.72257499**	**0.22136627**	**0.0011**	**0.330626694**	**1.42543421**	**0.0764**	**YES**
DMS display accurate travel time information - Strongly Agree and Agree	**1.71679175**	**0.25166322**	**0**	**0.7694762**	**0.2530687**	**0.0024**	**0.356900747**	**-2.6542829**	**0.004**	**YES**
How did DMS help reschedule travel - Canceling intended intermediate stops	-1.077908	0.5403193	0.046	-0.974305	0.46002044	0.0342	0.709622259	0.14599728	0.4404	NO
DMS helped save time - Strongly Agree and Agree	0.36755258	0.26764938	0.1697	0.54326489	0.22710993	0.0168	0.3510201	0.50057621	0.3085	NO

Significant at 95% confidence level
Significant at 90% confidence level

	Pre-Deployment		Post-Deployment
Number of observations	816	Number of observations	959
Log likelihood	-274.6168	Log likelihood	-346.0623
Restricted log likelihood	-356.1727	Restricted log likelihood	-407.3674
Chi-squared (Degrees of Freedom)	163.1118 (9)	Chi-squared (Degrees of Freedom)	122.6103 (9)
Prob [ChiSqd > value]	0.0000000	Prob [ChiSqd > value]	0.0000000
Psuedo R-Squared	0.22898	Psuedo R-Squared	0.15049

As it can be seen from the table, many of the variables show a significant difference between the two survey models. The coefficient corresponding to DMS travel time accuracy (Strongly Agree and Agree) showed a statistically lower coefficient in the post-deployment model at a 95% confidence interval. This shows that travelers who are satisfied with accuracy of travel time on DMS are not necessarily associated with a higher likelihood of being satisfied with overall traffic information on toll roads in the post-deployment model. The coefficient corresponding to increased number of alternate routes known showed a statistically higher coefficient in the post-deployment model at a 95% confidence interval. This shows that travelers who are satisfied with special event information displayed on DMS are associated with a higher likelihood of being satisfied with overall traffic information on toll roads in the post-deployment model. The coefficient corresponding to DMS helpful for special event information (Strongly Agree and Agree) shows a statistically lower coefficient between the two models at a 90% confidence interval. This shows that travelers who have higher network familiarity are associated with a higher likelihood of being satisfied with overall traffic information on toll roads in the post-deployment model.

As it is shown in the pre-deployment model, users seem more satisfied if they are infrequent users and have higher network familiarity. DMS attributes associated with higher levels of customer satisfaction include acquisition of traffic information on toll roads, provision of hazard warnings and accuracy of travel time information. Also, if DMS helped to reschedule travel by having the traveler cancel intended intermediate stops, the user would be less likely to be satisfied with travel information.

As it is shown in the post-deployment model, users seem more satisfied if they are infrequent users and travel for non work/school related purposes. DMS attributes associated with higher levels of customer satisfaction include provision of hazard warnings, provision of special event information, accuracy of travel time information and perception of time saving benefits. Also, if DMS helped to reschedule travel by having the traveler cancel intended intermediate stops, the user would be less likely to be satisfied with travel information.

It should also be noted that some of the variables for either the pre or post-deployment models may not show to be significant. Although this may be true, it is shown that each time one of the variables is not significant in one of the models, it was shown to be significant in the other model.

5.3 Logit Model for Revealed Preference for Diversion

5.3.1 Theoretical Variable Selection

To model response to RP Diversion, pre-deployment survey question (Q21) and post-deployment survey question (Q28) were targeted and modeled with 13 questions thought to be theoretically important. These theoretically important variables were originally selected for the pre-deployment analysis, but for the sake of comparison, these same variables will be used to compare between the pre and post-deployment survey results. It should be noted that for this section of the modeling, only pre-deployment survey version 14A was used, with only a total of 500 responses of which 255 respondents were asked Q21. For the post-deployment survey the full 1500 responses were used of which 732 respondents were asked Q28.

Using the results of the pre and post-deployment survey results, pre-deployment survey question 21 and post-deployment question 28 (What did you do in response to the unexpected congestion?) are modeled as binary variables as shown below:

1 = Success (b. exited the toll road and got back on toll road at a different location, c. exited the toll road and continued all the way to destination on an alternate route, d. abandoned journey and returned to origin),

0 = Failure (a. stayed on the toll road and waited it out).

The important explanatory variables that were theoretically relevant for explaining the propensity of the pre-deployment survey commuters to divert off toll roads when encountering unexpected delay are listed in Table 37.

Table 37: Important Explanatory Variables for RP Diversion (Pre Q21/Post Q28)

Pre	Post	Variables	# of Levels	Levels of Explanatory Variables
-	-	County	3	Orange, Seminole, Osceola
-	-	Gender	2	Male, Female
Q2	Q2	Most traveled toll road	4	SR 408, SR 417, SR 429, SR 528
Q3	Q3	Number of trips on the most traveled toll road	4	<1, 1-5, 6-10, >10
Q4	Q4	Main purpose of most frequent trips	5	Work, Shopping, School, Recreational, Other
N/A	Q5	Travel time on the most traveled toll road	5	Below 15 min, 15 min to 30 min, 30 min to 45 min, 45 min to 60 min, Above 60 min
Q5	Q6	Number of alternate routes known	5	None, 1, 2, 3, 4 or more
N/A	Q7	Travel time on alternate route	5	Below 15 min, 15 min to 30 min, 30 min to 45 min, 45 min to 60 min, Above 60 min
Q6	Q8	How do you pay tolls	2	Cash, E-PASS/SUN-PASS
Q8	Q10	Acquisition of traffic information	5	DMS, Radio, 511, Other, None
Q9	Q11	Satisfied with traveler information provided on the toll road	4	Strongly Agree, Agree, Disagree, Strongly Disagree
Q10	Q12	Knowledge of DMS on OOCEA toll roads	2	Yes, No
N/A	Q18	Abnormal travel time displayed on the DMS	2	Yes, No
N/A	Q19	Divert due to abnormal travel times	2	Yes, No
Q19	Q22	The cause of the unexpected congestion	6	Accident, Disabled Vehicle, Construction/road work, Weather Related, Other, Don't Know
Q20	Q23A/B	How first learned of the unexpected congestion	5	DMS, Radio Traffic Reports, 511 Telephone, Direct observation of congestion, Other means
N/A	Q24	Location (Toll Road) where the congestion was experienced	4	SR 408, SR 417, SR 429, SR 528
N/A	Q25A/B	Direction on the toll road when the congestion was experienced	4	East-bound, West-bound, North-bound, South-bound

Pre	Post	Variables	# of Levels	Levels of Explanatory Variables
Q22	Q31	Response to 30 minutes of unexpected congestion (SP)	4	Stay on the toll road, exit toll road & get back on at a different location, Exit toll road & continue all the way to destination, Abandon journey
Q23A	Q26	Amount of delay the unexpected caused	4	Up to 10 minutes, 10-20 minutes, 20-30 minutes, Over 30 minutes
N/A	Q27	Time period of travel during the congestion experience	3	Weekday morning rush hours, Weekday afternoon and evening rush hours, Non-rush hours and/or weekend
N/A	Q29	Did DMS influence your response to congestion	2	Yes, No
Q25	Q32	How did DMS help you reschedule your travel	5	Adding unintended intermediate stops, Canceling intended intermediate stops, Inform someone you are running late, Other, Did not help
Q26	Q33	Did DMS save you time	4	Strongly Agree, Agree, Disagree, Strongly Disagree
Q30	Q39	Age	5	18-25, 26-35, 36-50, 51-65, 65+
Q31	Q40	Education Level	5	High School, Some College, Associate Degree, Bachelors Degree, Post Graduate Degree
N/A	Q41	How long have you resided in Central Florida	5	Less than 6 months, Between 6 to 12 months, Between 1 to 5 years, Between 5 to 10 years, More than 10 years

5.3.2 A Priori Expectations for the Explanatory Variables for Pre and Post-Deployment Diversion

Table 38 summarizes the a priori expectations for the explanatory variables for the RP diversion.

Table 38: A Priori Expectations for Pre and Post-Deployment Diversion Models

Variables (Pre Q# / Post Q#)	Pre Deployment A Priori Expectations	Post Deployment A Priori Expectations	Is Change Expected in the Post Deployment Effect
County	OOCEA toll roads are in Orange County. *Orange county residents might be more familiar with the OOCEA toll roads and would be more likely to divert.*	OOCEA toll roads are in Orange County. *Orange county residents might be more familiar with the OOCEA toll roads and would be more likely to divert.*	Increased deployment of DMS might change the diversion behavior of other counties
Gender	NA	Gender of the respondent might influence the propensity to divert. For example, females might shun risky maneuvers for diversion, in the interest of remaining on the toll road, which they might perceive as safe.	
Q2 / Q2 – Most traveled toll road	SR 408 is the most congested, and had the only DMS located on it in the pre-deployment period. *SR 408 travelers may see more congestion than travelers on SR 417, SR 429, or SR 528 making them more likely to divert*.	*SR 408 and SR 417 are the most used toll roads. SR 408 travelers may see more congestion than travelers on SR 417, SR 429, or SR 528 making them more likely to divert*.	Increased deployment of DMS might change the diversion behavior on other toll roads
Q3 / Q3– Number of trips on the most traveled toll road	*Frequency of travel* might influence travelers' familiarity with the toll road, and therefore, influencing them differently towards diversion.	Frequency of travel might influence travelers' familiarity with the toll road, and therefore, influencing them differently towards diversion.	We do not expect a significant change in this variable 's effect between pre and post deployment
Q4 / Q4– Main purpose of most frequent trips	Work and School trips are bound by tighter time constraints than Shopping and Recreational trips. Travelers with *Work and School purposes might react differently to diversion.*	Work and School trips are bound by tighter time constraints than Shopping and Recreational trips. Travelers with *Work and School purposes might react differently to diversion.*	We do not expect a significant change in this variable 's effect between pre and post deployment

Variables (Pre Q# / Post Q#)	Pre Deployment A Priori Expectations	Post Deployment A Priori Expectations	Is Change Expected in the Post Deployment Effect
Q5 - Travel Time on the toll road	NA	The travel time on the toll road, combined with the knowledge of alternate routes and the travel time on alternate routes might influence the propensity of the commuters to divert. For instance, commuters with longer trip times might consider diverting as easily as do commuters with shorter trip times.	
Q5 / Q6 – Number of alternate routes known	As number of alternate routes known increases, familiarity of the traveler with the network increases. *Higher familiarity could be associated with the travelers' likelihood to divert*.	As number of alternate routes known increases, familiarity of the traveler with the network increases. *Higher familiarity could be associated with the travelers' likelihood to divert*.	We do not expect a significant change in this variable 's effect between pre and post deployment
Q7 - Travel Time on the alternate route	NA	The travel time on the alternate route if known, combined with the travel time on the toll road might influence the likelihood of diversion.	
Q8 - Mode of payment of tolls	The presence of cash / E-pass might influence diversion behavior	The presence of cash / E-pass might influence diversion behavior	
Q8 / Q10 – Acquisition of traffic Information	The source of traveler information could influence the travelers' choice to divert. *The source of traveler information could be associated with the travelers' likelihood to divert.*	The source of traveler information could influence the travelers' choice to divert. *The source of traveler information could be associated with the travelers' likelihood to divert.*	We expect that this variable might have a different effect on diversion with increased deployment of DMS in the post deployment period.
Q9 / Q11– Satisfied with traveler information provided on the toll roads	The travelers' *overall satisfaction with the travel information provided on the toll roads* could influence the travelers' decision to divert.	The travelers' *overall satisfaction with the travel information provided on the toll roads* could influence the travelers' decision to divert.	We do not expect a significant change in this variable 's effect between pre and post deployment

Variables (Pre Q# / Post Q#)	Pre Deployment A Priori Expectations	Post Deployment A Priori Expectations	Is Change Expected in the Post Deployment Effect
Q10 / Q12 – Knowledge of DMS on OOCEA Toll Roads	The travelers' *knowledge of DMS on the toll roads* could influence their likelihood to divert.	The travelers' *knowledge of DMS on the toll roads* could influence their likelihood to divert.	With increased deployment of DMS, the travelers are more aware of congestion issues and could behave differently than the pre-deployment
Q18 - Abnormal travel times displayed on the DMS	NA	The travelers' past experience with abnormal travel times might influence their decision to divert.	
Q19 - Divert due to abnormal travel times	NA	*The travelers' past reaction to abnormal travel times might influence their decision to divert.*	
Q19 / Q22 – The cause of the unexpected congestion	*Different causes of unexpected congestion* could influence the travelers' likelihood to divert differently.	*Different causes of unexpected congestion* could influence the travelers' likelihood to divert differently.	Availability of prior information of incidents via DMS might make diversion attitudes towards different causes differently in the post deployment period.
Q20 / Q23(A/B) – How first learned of the unexpected congestion	*The source from which the traveler first heard of the unexpected congestion* could influence the travelers' likelihood to divert.	The source from which the traveler first heard of the unexpected congestion could influence the travelers' likelihood to divert.	Extensive deployment of DMS could modify diversion behavior of the commuters in the post deployment
Q24 - Location (Toll Road) where the congestion was experienced	NA	The location of the congestion (the toll road) experience might influence the decision to divert	

Variables (Pre Q# / Post Q#)	Pre Deployment A Priori Expectations	Post Deployment A Priori Expectations	Is Change Expected in the Post Deployment Effect
Q25A / Q25B - Direction on the toll road when the congestion was experienced	NA	The location of the congestion (the direction) experience might influence the decision to divert	
Q23A / Q26 - Additional trip time added due to congestion	Increasing delay would increase the likelihood to divert.	Increasing delay would increase the likelihood to divert.	We do not expect a significant change in this variable 's effect between pre and post deployment
Q27 - Time period of travel during the congestion experience	NA	The diversion decision might be different for different time periods (rush hours vs non-rush hours).	
Q29 - Did the DMS influence your response to congestion	NA	*The DMS message might influence the decision to divert.*	
Q22 / Q31– Response to 30 minutes of unexpected congestion (SP)	*How the traveler would respond to a fictitious situation in which there is 30 minutes of unexpected delay* is likely to influence the likelihood to divert.	How the traveler would respond to a fictitious situation in which there is 30 minutes of unexpected delay is highly likely to influence the likelihood to divert.	We do not expect a significant change in this variable 's effect between pre and post deployment
Q25 / Q32 – How did DMS help reschedule travel	Whether the respondent reschedules and if the DMS help in that aspect might influence their decision to divert	Whether the respondent reschedules and if the DMS help in that aspect might influence their decision to divert	
Q26 / Q33 - Do DMS help save time	*Whether the respondent feels that the DMS messages help save travel time might influence their decision to divert.*	*Whether the respondent feels that the DMS messages help save travel time might influence their decision to divert.*	

Variables (Pre Q# / Post Q#)	Pre Deployment A Priori Expectations	Post Deployment A Priori Expectations	Is Change Expected in the Post Deployment Effect
Q30 / Q39 – Age	*Age group might influence the likelihood to divert*	The age of the travelers might influence their likelihood to divert.	We do not expect a significant change in this variable 's effect between pre and post deployment
Q31 /Q40 – Education	The education level of the travelers might influence their likelihood to divert.	The education level of the travelers might influence their likelihood to divert.	We do not expect a significant change in this variable 's effect between pre and post deployment
Q41 – How long have you resided in Central Florida	NA	The time of residence of the travelers might influence their likelihood to divert.	

NA: Question not asked

5.3.3 Final Post-Deployment Diversion Model

It should be noted that since the post-deployment survey shows more important results than the pre-deployment survey, a separate final post-deployment diversion model should be calculated.

In the pre-deployment survey, diversion models were estimated using responses available from pre-deployment survey. The pre-deployment survey was conducted with only one DMS operational on the OOCEA toll road system. About one and a half years later, the post deployment survey was conducted with about 30 DMSs operational on the OOCEA toll road system. The questions asked were a little more extensive than the pre-deployment survey, and a diversion model was created from the post-deployment survey.

The dependent variable was the response to Question 28 in the post deployment survey which is the revealed diversion question. It had 4 responses.

Q28) What did you do in response to the unexpected congestion? (Only Select One)

a) Stayed on the toll road and waited it out **(if the answer is "a" ask the blue highlighted question)**

b) Exited the toll road and got back on toll road at a different location

c) Exited the toll road and continued all the way to destination on an alternate route

d) Abandoned journey and returned to origin/home

If the response was a), the response was coded as 0 (stayed). If the response was b) or c) or d), then it was coded as 1 (diverted). Therefore, when this response was modeled, the coefficient of each variable showed the effect of the variable on the likelihood of diversion.

The following Table 39 shows the questions asked which were used for modeling the post-deployment diversion model:

Table 39: Variables Used in Final Post-Deployment Diversion Model

Independent Variables	Dependent Variable - Revealed Diversion	Question Type
County	√	Demographic
Gender	√	Demographic
Question 2 – Most traveled toll road	√	Most Frequent trip
Question 3 – Number of trips on the most travelled toll road	√	Most Frequent trip
Question 4 – Main purpose of most frequent trips	√	Most Frequent trip
Question 5 - Travel time on the most traveled toll way	√	Most Frequent trip
Question 6 – Number of alternate routes known	√	Most Frequent trip
Question 7 - Travel time on alternate route	√	Most Frequent trip
Question 8 – How do you pay tolls	√	Most Frequent trip
Question 9 - Type of vehicle used for trips	√	Most Frequent trip
Question 10 - Acquisition of traffic Information	√	Traffic Information
Question 11 - Satisfied with traveler information on toll roads	√	Traffic Information
Question 12 - Recall seeing DMS on toll roads	√	Knowledge
Question 13 - Are DMS helpful in improving traveling experience		
Question 14 - Are DMS helpful in providing hazard warnings		
Question 15 - Are DMS helpful in giving special event information		
Question 16 - Are DMS easy to read while driving		
Question 17 - Do DMS display accurate travel time information		
Question 18 - Abnormal travel times displayed on the DMS	√	DMS
Question 19 - Divert due to abnormal travel times	√	DMS
Question 20 - Reason for not diverting off the toll road		
Question 21 - Encounter congestion in the past 6 months		
Question 22 - Cause of unexpected congestion	√	Congestion trip
Question 23 A / Question 23 B - First source of unexpected congestion	√	Congestion trip

Independent Variables	Dependent Variable - Revealed Diversion	Question Type
Question 24 - Location (Toll Road) where the congestion was experienced	√	Congestion trip
Question 25 A / Question 25 B - Direction on the toll road when the congestion was experienced	√	Congestion trip
Question 26 - Additional trip time added due to congestion	√	Congestion trip
Question 27 - Time period of travel during the congestion experience	√	Congestion trip
Question 28 - Response to unexpected congestion	√	Congestion trip
Question 29 - Did the DMS influence your response to congestion	√	Congestion trip
Question 30 – reason to continue on the toll road		
Question 31 - Stated preference to congestion	√	Stated Preference
Question 32 - How did DMS help reschedule travel	√	DMS
Question 33 - Do DMS help save time	√	DMS
Question 34 - SR436 vs Semoran		
Question 35 - SR426 Vs Aloma		
Question 36 - SR434 Vs Alafaya		
Question 37 - Should DMS inform you of abnormal conditions like accident		
Question 38 - How should the DMS inform you of this abnormal situation		
Question 39 – Age	√	Demographic
Question 40 – Education	√	Demographic
Question 41 - How long have you resided in Central Florida	√	Demographic

A univariate analysis was performed with responses with each of the questions. For every question, each response was coded as a binary variable – 1 indicating if the particular response was chosen and 0 if it is not. For example, question 2 had four choices A, B, C, D, and a particular respondent chose B as their response. In this scenario, four binary variables were created – Q2_A, Q2_B, Q2_C, Q2_D. Q2_A, Q2_C, Q2_D were set to 0 and Q2_B was set to 1. However, in the model, only 3 of these binary variables were used, and the left out binary variable served as the base case, to which the effect of other variables (or responses) was compared to.

Out of a total of 1500 possible respondents, not all were involved in congestion, and therefore faced with a diversion decision. The number of respondents faced with a diversion decision was counted from the response to question 21. There were 732 responses that answered "yes" to question 21. These responses were used for diversion models. Table 38 shows the a priori expectations for the pre and post-deployment diversion model.

Some of these variables – for example: No. of alternate routes known (Q6) were coded as ordinal variables to get the best possible model. This was because some variables could be better interpreted for modeling purposes if they were associated with an order that is intuitive. As an instance, models with no. of alternate routes coded as nominal variables and as an ordinal variable could be interpreted in two ways. The one with the ordinal coding for the variable could be interpreted as– as the number of alternate routes increase, the propensity to divert increases. With nominal variable coding, the kind of interpretation possible was – if the no. of alternative routes known was 3, (compared to none, 1, 2, or 4), the propensity to divert increases. Therefore it was decided to proceed with the ordinal coding with this variable.

Some of the responses (especially the DMS dependent ones) were not asked to all respondents involved in the congestion scenario. These variables were set to missing in the dataset. For example the question:

Q18) While traveling on OOCEA toll roads within the past 6 months, have you seen abnormal travel times displayed on Dynamic Message Signs (DMS), such as 20 minutes or more above the expected travel time displayed?

a) Yes

b) No (If no proceed to question 21)

was asked to respondents who know of DMS (answered Yes to Q12).

It was hypothesized that the response to this question might have some bearing on the propensity of the commuters to divert. However, if we code this variable with just two levels – (1 for Yes, and 0 for No), and create two binary variables, we would be excluding the data points (or responses) which were set to missing because the respondents do not know DMS.

To get around this, questions similar to Q18 were coded as variables with 3 levels – a) Yes, b) No and c) Don't know of DMS. The third level was derived from the response "No" to Question 12 (Do you know of DMS on the toll roads).

For example, let us say a respondent answered 'Yes' to Q12 (knowledge of DMS on toll roads) and 'Yes' to Q18. The corresponding binary variable coding would be:

Q12_Yes = 1   Q12_No=0   Q18_Yes = 1   Q18_No=0

If the respondent answers 'No' to Q12, he would not be asked Q18, so Q18_Yes and Q18_No would be coded as 'missing'. To get around this, we combined Q12_No with Q18_Yes and Q18_No, so that when Q12_No = 1, Q18_Yes=0 and Q18_No =0

This way, we could include Q18_Yes, Q18_no, Q12_no in our models and Q12_no could serve as the base case. This strategy can be extended to include all DMS related variables. In effect, this was same as coding all the non-answered DMS questions with a zero. As was explained earlier, the dependent variable was coded as a binary variable(coded as Stayed = 0 and Diverted = 1) and diversion was modeled using a binary logit model.

A preliminary model was created with just the travel times on the toll road, the travel time on the alternate route, the number of alternative routes known, the expected delay on the toll road during the congestion experience and the sources of information. This is shown in Table 40.

Table 40: Preliminary Diversion Model with Travel Times on Toll Road and Alternate Routes, with Generally used Information Sources

Variable	Description	Levels	Coefficient	Standard Error	P-value	Mean
Constant			-2.03096389	0.36434666	0	
Q5_ORDIN	Travel time on toll road	Ordinal (7.5, 22.5, 37.5, 52.5, 67.5)	-0.01706348	0.00832413	0.0404	28.0357143
Q6_ORDIN	Number of alternative routes known	Ordinal (1,2,3,4)	0.28780105	0.07995786	0.0003	2.60267857
Q7_ORD2	Travel time on alternate road	Ordinal (7.5, 22.5, 37.5, 52.5, 67.5)	0.00084777	0.00672005	0.8996	35.1339286
Q26_ORD2	Expected delay added during congestion	Ordinal (5, 15, 25, 35)	0.04457746	0.00856333	0	15.3571429
Q10_1	Source of traffic information acquisition - DMS	DMS = 1, everything else = 0	0.01179173	0.2009687	0.9532	0.30208333
Q10_2	Source of traffic information acquisition - Radio	Radio = 1, everything else = 0	0.18357393	0.18851363	0.3302	0.42857143
Q10_3	Source of traffic information acquisition - 511	511 = 1, everything else = 0	0.46402777	0.30655489	0.1301	0.08035714
Q10_4	Source of traffic information acquisition - Other	Other = 1, everything else = 0	-0.1880335	0.27508543	0.4943	0.14583333

Number of observations - 672 (not including commuters who do not know any alternate routes).

Log likelihood function	-381.3341	Restricted log likelihood	-406.5279
Chi squared	50.38767	Degrees of freedom	8
Prob[ChiSqd>value]=	0.0000000	Pseudo R-squared	0. 04639
Correct prediction	70.68452%	Number of observations	672

In the following steps, all variables thought to be relevant in affecting diversion were used, in addition to the variables already in the preliminary model and the insignificant ones were weeded out. The additional variables that were added are the demographic variables (Age, Gender, Education, Length of Residency), trip characteristics (toll road used, trip purpose, number of trips, etc), and the congestion experience variables (cause of the congestion, time of experience of congestion, etc) and DMS related variables during congestion experience. Not all variables used were significant at least at a 90% confidence level. Therefore, the final model was fit with only those variables that were deemed to be theoretically important and those that could be supported by statistical significance. A significant exception to this is the inclusion of traffic information acquisition variables (DMS, Radio, Other). These were included in spite of being insignificant so that a general idea can be formulated on their effect on diversion. However, these should be interpreted with caution. Table 41 shows the explanations of effects used in the diversion model.

Table 41: Explanation of Significant Effects in the Post Deployment Survey

Variable	Variable Description	Variable - Response Level	Coefficient	p-value	More likely to …
Constant			-4.29019503	0	Stay
Q39_2	Age group	25-35	0.97297157	0.0052	Divert
Q2_1	Frequent toll road used	SR408	0.89086701	0.0048	Divert
Q2_2	Frequent toll road used	SR417	0.68258203	0.0236	Divert
Q3_4	Number of one way trips per week	More than 10 trips	0.46190365	0.1264	Not significant
Q5_ORDIN	Travel time one way on toll road	Ordinal variable (7.5, 22.5,37.5,52.5, 67.5)	-0.01939491	0.0373	Stay
Q7_ORD2	Travel time one way on alternative road	Ordinal variable (7.5, 22.5,37.5,52.5, 67.5)	0.00481174	0.5281	Not significant
Q6_ORDIN	Number of alternative routes known	Ordinal variables (1,2,3,4)	0.23408321	0.0079	Divert
Q8_1	Mode of payment	cash	0.66616727	0.0031	Divert
Q10_1	Source of traffic information acquisition	DMS	-0.11095692	0.6222	Not significant
Q10_2	Source of traffic information acquisition	Radio	0.18130408	0.3888	Not significant
Q10_3	Source of traffic information acquisition	511	0.73570882	0.0309	Divert
Q10_4	Source of traffic information acquisition	Other	-0.21347521	0.4986	Stay
Q19_L1	Divert in case of abnormal travel time	Yes	0.58990798	0.0116	Divert
Q22_A_C_	Cause of congestion	Accident, Construction	-0.58257861	0.0765	Stay
Q26_ORD2	Expected additional travel time added (delay)	Ordinal variables (5,15,25,35)	0.04679548	0	Divert
Q27_1	Time period when congestion was experienced	Weekday rush hour	0.41260752	0.0594	Divert
Q29_L1	Did a DMS influence your response to congestion	Yes	0.71244852	0.0005	Divert
Q31_DIVE	Stated preference to congestion	Diverted	1.68465213	0	Divert

Significant at 95% confidence level
Significant at 90% confidence level

Log likelihood function	-328.1423	Restricted log likelihood	-406.5279
Chi squared	156.7713	Degrees of freedom	18
Prob[ChiSqd>value]	0.0000000	Pseudo R-squared	0. 19282
Correct prediction	76.19048%	Number of observations	672
Iterations completed	6	Hosmer-Lemeshow chi-squared	6.84603

5.3.4 Description of Variables in the Final Post-Deployment Diversion Model

From the value of the constant in the model, it was deciphered that all other variables being equal to base case, the commuters were likely to stay, due to the value being significant and negative.

The age group 25-35 was more likely to divert compared to other age groups when faced with diversion. SR408 and SR417 commuters were more likely to divert from the toll road than the commuters who used other toll roads. This could be because these two roads carry a lot more traffic in the Central Florida region than the others, and also that these two roads had maximum number of DMS deployed on them out of the four toll roads (10 on SR408, 9 on SR417, 6 on SR429, 4 on SR528) when the post deployment survey was conducted.

The variable that showed the number of trips per week greater than 10 was not significant at 90% confidence, but was marginally significant at 85% (p-value: 0.12). These were very frequent travelers, who might be inclined to divert when faced with congestion. The travel time on the toll road was significant at 95% confidence level. It showed that commuters with longer travel times on the toll road were more content to stay on the toll road when faced with congestion.

The knowledge of alternative routes was significant in the post deployment. As the number of alternate routes known increased, the propensity to divert increased. As familiarity with the network increases, drivers tend to use the alternative routes to counter the effects of congestion.

In the post deployment, commuters who paid toll using cash were more likely to divert compared to commuters who used E-pass. This could be due to the fact that E-pass users did not have to consider additional delays at toll plazas, while cash paying commuters had to consider additional delays at the toll plazas, beyond the delay due to congestion they already faced. Also, the travel times displayed on the DMS signs were estimated from the E-pass carrying vehicles that acted as probe vehicles. Therefore, it is possible that cash paying customers might find small discrepancies between their travel times and those experienced by the E-pass customers due to delays at toll plazas.

Travelers who used 511 for acquiring traffic information were more likely to divert when faced with congestion, than others. However, the sign for the DMS was negative, but it has a very high p-value, making it statistically insignificant. Therefore it is difficult to comment on how much are the DMS users likely to divert.

Travelers who had witnessed abnormal travel times on the DMS and diverted, were very likely to divert in the case of congestion, when compared to those who either stayed in spite of the abnormal travel times or who did not know of DMS on OOCEA toll roads. This ties in with the past experience of the commuters with the DMS messages. If commuters had witnessed abnormally high and seemingly unreasonable travel times on DMS, they were very likely to repeat the same action in the case of congestion where the travel time message on the DMS was also accompanied by other sources of information and / or visual observation.

Travelers who were involved in congestion due to an accident or construction were very likely to have stayed. This does not imply causality as travelers who have stayed on the toll road during congestion would know the reason behind it. Reasons other than accident and construction (specifically weather related) were likely to promote diversion, as commuters might divert off the toll road for safety reasons. As the perceived delay (additional travel time added) on the toll road increased, the travelers were more likely to divert.

Travelers who were aware of DMS and who stated that the DMS helped them in their diversion decision were very likely to divert, when compared to those who were unaware of DMS or said that it did not help them. This conclusion, however, needs some caution. It is very likely that commuters who diverted, would credit the DMS for helping them judge the delay. However, for most of the commuters, the default action would be to stay on the toll road. Even if the travel time information on the DMS helped them make that decision (to stay) sub-consciously, the respondents might not easily attribute it to DMS.

Travelers who stated that they would divert in a fictitious congestion scenario with a 30 minute delay were very likely to divert when faced with congestion. The stated preference is therefore a very good indicator of the propensity to divert.

5.3.5 Comparison of Pre and Post-Deployment Diversion Models

Although a post-deployment diversion model was developed in the previous section, another objective of this study was to compare the pre and post diversion models and comment on the significant changes between the two survey responses. This would be an indicator of if the extensive employment of DMS has an effect on the diversion behavior of the users of the toll road.

The comparison of the pre and post deployment models was not very straightforward. This was due to the fact that the diversion model in the post deployment model included variables that were not asked during the pre-deployment (e.g., travel time on the usual toll road, travel time on the alternate route, etc). Therefore, pooling the pre and post diversion models and using a dummy variable for pre and post survey responses (as in the case of satisfaction models) would not be very useful as critical variables will be missing and the interpretation of the coefficient of dummy variable will not point to straightforward conclusions.

The other approach was to try to compare the coefficients and significance of the critical variables between pre and post deployment. As far as possible, both pre and post-deployment models needed the same specification, but the pre-deployment model missed the travel time variables. However, a common specification for both the models was created using critical variables that were at least significant in one of the models. The critical variables used in both specifications are – the toll road used, the number of alternative routes known, the mode of payment for tolls, source of acquisition for traffic information, and the expected delay. Travel time on the toll road and alternative route are used in the post deployment model only.

Table 42 below shows the comparison between the variables that are significant in pre and post and how they can be explained.

Table 42: Comparison and the Test for Significance of Difference in Coefficients between Pre and Post-Deployment Survey Variables

	Pre-Deployment		Post-Deployment		Explanation	
Variable	Coefficient	p-value	Coefficient	p-value	Pre-Deployment	Post Deployment
Constant	-3.50838005	0	-3.5857978	0	All other variables being the same, the commuters are likely to stay	All other variables being the same, the commuters are likely to stay
Most frequently used toll road – SR408	0.88541683	0.0579	0.84527364	0.005	SR408 commuters are likely to divert	SR408 commuters are likely to divert
Most frequently used toll road – SR417	0.24507308	0.5924	0.58145122	0.0442	Not significant	SR417 commuters are likely to divert
One way travel time on toll road (minutes)	NA	NA	-0.01747971	0.0482	Not significant	Commuters with longer trips are likely to stay
Number of alternative routes known (1,2,3,4)	0.00656026	0.9604	0.26449909	0.0017	Not significant	Commuters who know more alternative routes are likely to divert
One way travel time on alternate route (minutes)	NA	NA	0.00323306	0.6539	NA	Not significant
Mode of toll payment (E-pass = 1, Cash = 0)	0.42166429	0.2113	-0.65956814	0.002	Not significant	Commuters with E-pass are more likely to stay
Source of traffic information acquisition – DMS	0.1761129	0.6191	-.325845E-04	0.9999	Not significant	Not significant
Source of traffic information acquisition – Radio	0.66139796	0.0468	0.24445629	0.2239	Commuters who acquire traffic information from Radio are likely to divert	Not significant
Source of traffic information acquisition – 511	0.92323549	0.1316	0.78794082	0.0165	Commuters who acquire traffic information from 511 are likely to divert	Commuters who acquire traffic information from 511 are likely to divert
Source of traffic information acquisition - Other	0.6971643	0.1008	-0.14590345	0.6232	Commuters who acquire traffic information from sources other than DMS, Radio and 511 are likely to divert	Not significant
Expected delay due to congestion (minutes)	0.03232204	0.0276	0.04686622	0	As perceived delay increases, the propensity to divert	As perceived delay increases, the propensity to

					increases	divert increases
Stated preference to diversion(Stay=0, Divert =1)	1.34051718	0.0005	1.66669048	0	Commuters who stated they would divert in a fictional 30 minute congestion scenario are more likely to divert	Commuters who stated they would divert in a fictional 30 minute congestion scenario are more likely to divert

NA: Question Not Asked / Not Applicable

Significant at 95%

Significant at 90%

	Pre-Deployment		Post-Deployment
Number of observations	232 (without respondents who knew no alternate routes)	Number of observations	672 (without respondents who knew no alternate routes)
Log likelihood	-135.7542	Log likelihood	-349.9724
Restricted log likelihood	-153.4827	Restricted log likelihood	-406.5279
Chi-squared (Degrees of Freedom)	35.45688 (10)	Chi-squared (Degrees of Freedom)	113.111 (12)
Prob [ChiSqd > value]	0.1043150E-03	Prob [ChiSqd > value]	0.0000000
Psuedo R-Squared	0.11551	Psuedo R-Squared	0.13912
Hosmer-Lemeshow chi-squared	6.01253	Hosmer-Lemeshow chi-squared	6.70968
Pct. Correct Prec	68.10345%	Pct. Correct Prec	73.80952%

On comparison, it can be seen that in both the pre and the post deployment, commuters were more likely to stay on the toll road everything else being equal to the base case– due to higher magnitude of the constant in the post-deployment.

It can be seen that the coefficients for SR408 and SR417 are significant in the post-deployment. Therefore, in the post-deployment period, commuters on SR408 and SR417 were more likely to divert, compared to just SR408 in the pre-deployment. This is what we might expect, as in the pre-deployment, there was only one DMS on SR408. Between the pre and post-deployment period, additional DMS were deployed on SR408, SR417, SR429 and SR528. However, SR408 and SR417 carry a lot more traffic compared to SR429 and SR528. Also, more DMS were installed on SR408 and SR417 than the latter roads and it was expected that with traffic information available, commuters on SR408 and SR417 were more likely to divert than the other roads.

The number of alternative routes known became significant in the post-deployment survey. In the pre-deployment survey, the number of alternative routes known did not affect the diversion propensity significantly. However, its significance increased in the post deployment period, where drivers when faced with congestion, did not deter from diverting. The coefficients are significantly different between pre and post deployment, and the coefficient for the post deployment is positive. It was concluded that under the presence of extensive travel time information available from the DMS in the post-deployment, drivers more familiar with the network were more likely to divert when faced with congestion.

One of the unexpected results of the modeling effort showed an interesting behavior of the commuters with respect to their mode of payment. It showed that E-pass holders were more likely to stay on the toll road when faced with diversion decision in the post-deployment period than cash payers. In the pre-deployment survey, the mode of payment did not significantly affect the diversion decision. It makes sense, as E-pass holders do not expect to have any additional delay at the toll plazas, than due to congestion. Cash payers might take into consideration, possible additional delays at toll plazas that might encourage them to divert. In the pre-deployment scenario, due to a greater uncertainty in travel times, and with only one DMS deployed, the mode of payment did not significantly affect the diversion decision.

With respect to sources used for acquiring traffic information, the pre-deployment coefficients for Radio, 511 and other sources were significant at 95%, 85% and 90% respectively. In the post deployment scenario, all sources except for 511 were insignificant. DMS turned out to be insignificant in both pre and post deployment. This means that while routine users of Radio, 511 and sources other than DMS were more likely to divert in the pre-deployment period, these sources do not have as significant an impact on diversion in the post deployment. DMS apparently did not have a significant impact on diversion either in the pre or post deployment scenario. The negative sign of the DMS variable in the post deployment could mean that the users of DMS are more likely to stay on the toll road in the case of congestion. However, it is statistically insignificant and so, this conclusion needs to be meted out with caution.

The additional perceived travel time added to congestion or perceived delay was coded as an ordinal variable – with midpoints of the additional time categories as the levels (5, 15, 25, 25 minutes). This variable was significant at 95% confidence level in both the pre-deployment period and the post-deployment. In the post-deployment scenario, with extensive DMSs deployed, the commuter is more certain of the delay (through the travel time messages posted on the DMS), and therefore has a more objective measure of it, thus minimizing the uncertainty to some extent. This makes the decision to divert easier. And the significantly positive coefficient of the delay variable for pre and post-deployment proves that as delay increases, the propensity to divert increases.

The stated preference variable stayed significant and positive in both the pre and post deployment survey models, implying that commuters who said they would divert in a fictional 30 minute congestion scenario, were very likely to do so when faced with real life congestion.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary of Findings

The results of both the pre and post-deployment surveys are discussed in this thesis, but it should be noted that the more telling results are those of the post-deployment survey. The results of the post-deployment survey show the complete picture of the impact of DMS on travelers' experience on the OOCEA toll road network. The pre-deployment results are included to show an increase or decrease in certain aspects of travel experience with relation to DMS. One of the main objectives of this thesis was to measure the proportion of respondents who acknowledged DMS on the OOCEA toll road network. From the results of the pre and post-deployment surveys, there was a total increase of nearly 10% from 54.4% to 63.93% of respondents stating they have knowledge of DMS. From the categorical analysis, the results found that the highest percent knowledge of DMS is for the categories listed below:

- Age group: "18-25" (61.3% Pre) "36-50" (68.35% Post)
- Education Level "Some College" (56.63% Pre) "Associate Degree" (68.67% Post)
- Most used OOCEA toll road "SR 408" (57.25% Pre 70.13% Post)
- County "Orange County" (58.0% Pre 68.00% Post)

The satisfaction with DMS subject questions were measured using the grading system similar to a GPA. The DMS subject questions were only asked to those who recalled seeing DMS. The results showed to be mostly consistent with the pre-deployment survey results, with the following satisfaction levels shown to be significantly higher in the post-deployment survey:

- Satisfaction with special event information shown on DMS

- Travel time accuracy on DMS

With respect to formatting of the DMS, the following methods were preferred by the majority of respondents in both the pre and post-deployment surveys:

- Steady Message as a default DMS message format
- Flashing Message for abnormal traffic information (94% of respondents would like to be notified of abnormal traffic information)
- State road number to show which roadway (for Colonial – SR 50, Semoran – SR 436 and Alafaya – SR 434)
- "I-Drive" is a good abbreviation for International Drive
- If the distance to the international airport is shown on a DMS it thought to be the distance to the airport exit

The modeling of "satisfaction with traveler information on OOCEA toll roads" was performed to analyze and quantify the effects of various demographic, trip and DMS information related variables. Responses from pre-deployment survey question 9 and post-deployment question 11 were used as the dependent variable. However, the sample was limited to only the respondents who had recalled seeing DMS on the OOCEA toll roads. This was done to specifically examine the effect of DMS information related responses from the survey.

The first step in modeling the satisfaction was to pool the data from both of the survey results for a total of 1775 responses (816 responses from pre-deployment and 959 responses from post-deployment). From this pooled data it was found that there is no statistical change between pre and post-deployment satisfaction base on the significant variables used for modeling. Thus, the likelihood of being satisfied with traffic information is not affected significantly due to the pre and post-deployment survey.

The next step was to see if there is a significant change in the variables between the pre and post-deployment models. This comparison showed a significant difference in many variables modeled between the pre and post-deployment surveys. The coefficient corresponding to DMS travel time accuracy (Strongly Agree and Agree) shows a statistically lower coefficient between the two models at a 95% confidence interval. The coefficient corresponding to the model constant shows a statistically higher coefficient between the two models at a 95% confidence interval. The coefficient corresponding to DMS helpful for special event information (Strongly Agree and Agree) shows a statistically higher coefficient between the two models at a 90% confidence interval.

The final post-deployment diversion model was based on a total of 732 responses who answered that they have experienced congestion in the past 6 months. The final post-deployment diversion model is found for the more telling post-deployment survey results. The first step in modeling the post-deployment diversion model was to create a basic model with just certain variables based on travel time, alternate routes, and sources of information. Then a larger model was created based on all variables thought to be relevant in affecting diversion. Based on this final post-deployment diversion model, the following variables were found to increase the likelihood of diversion: age group (25-35), most traveled toll road (SR 408 or SR 417), an increased amount of alternate routes known, toll payment (travelers paying tolls with cash), acquiring traffic information from 511, travelers who witnessed abnormal travel times on DMS, increased perceived delay on the toll road and travelers stating DMS helped them in their diversion decision. On the other hand, based on the final post-deployment diversion model, the following variables were found to increase the likelihood of staying on the toll road: longer travel times and travelers involved in congestion due to an accident.

Based on a comparison between pre and post-deployment models containing similar variables, commuters were more likely to stay on the toll road everything else being equal to the base case. Also, it was shown that in the post-deployment model the respondents traveling on SR 408 and SR 417 were shown to be more likely to divert, but in the pre-deployment model only the respondents traveling on SR 408 were shown to be more likely to divert. This is an expected result since during the pre-deployment survey only one DMS was located on SR 408, and during the post-deployment survey there were DMS located on all toll roads. Also, an interesting result to be noted is that in the post-deployment survey, the number of alternative routes know became significant in the post-deployment survey. In the pre-deployment survey, the number of alternative routes known did not affect the diversion propensity significantly. Also, it should be noted from the comparison that in the pre-deployment survey model, the coefficients for acquiring traffic information from Radio, 511 and other sources were significant at 95%, 85% and 90% respectively. In the post-deployment survey, all sources except for 511 were shown to be insignificant.

6.2 Implementation Plan

From this thesis, the results show that with the addition of nearly 30 DMS signs on the OOCEA toll road network there was an increase in DMS knowledge of nearly 10%. This is an expected result since there was such a large increase in the number of DMS on the toll road network and is encouraging since it was shown to be a significant increase. As discussed before, the results of the post-deployment survey are the more telling and important of the two survey results. The results of the pre-deployment survey are included to show and increase or decrease between the two survey periods.

As was thought before, with the addition of more respondents acknowledging DMS because of increased exposure, the satisfaction subjects with DMS showed a lower satisfaction score. This result was expected with the increase in the number of DMS, but as it can be seen in this thesis, the overall percentage of people who strongly agree or agree with the DMS satisfaction subjects increased in many of the questions.

With respect to formatting on DMS, it was shown through the survey results that for abnormal traffic situations, a flashing message would be preferred on a DMS sign. Also, it can be seen from the pre and post-deployment survey results that most of the time when showing a roadway name the state road number would be preferred (for Colonial – SR 50, Semoran – SR 436 and Alafaya – SR 434). From the pre-deployment analysis, it was shown the respondents prefer a steady message as the default DMS formatting, the respondents accept “I-Drive” as an abbreviation for International Drive, and the respondents think that when the mileage is shown to the international airport that this corresponds to the mileage to the airport exit.

The satisfaction modeling results show that the travelers’ (who acknowledge DMS) satisfaction with traffic information provided on the network was influenced by the satisfaction agreement of the following DMS subjects:

- Hazard warnings
- Special event information
- Accuracy of travel time information

These results were shown to be consistent with the pre-deployment survey results. To improve satisfaction of traveler information, the above subjects should be addressed. It was found that travelers seem to be in agreement that DMS was helpful for giving hazard warnings. This was consistent between the pre and post-deployment surveys and it was obvious that the travelers find it important to be informed on events that are related to personal safety. The special event information was found in the pre-deployment survey to be the least in agreement, but this agreement percentage increased in the post-deployment survey. This result shows that with the increase of DMS on the toll road network, there would be more of a chance of someone seeing a message dealing with special event information, thus increasing satisfaction. As with the pre-deployment survey, DMS travel time accuracy was shown to be a significant variable when modeling overall satisfaction. This shows that the travelers' satisfaction is significantly based on the travel time accuracy on DMS. If the travelers observe inaccurate travel information displayed on DMS, they may not trust the validity of future messages. It is important to provide the most accurate travel information available and update crucial information such as significant increase in travel times and/or hazard warnings.

The RP traveler diversion behavior modeling results showed that in the post-deployment model, if the toll road used most by the traveler is either SR 408 or 417, they were more likely to divert. This was not the same in the pre-deployment model. In the pre-deployment model, only travelers who traveled the most on SR 408 were more likely to divert. This could be because the traveler now has more DMS signs available on SR 417, were as in the pre-deployment survey, these DMS signs were not available. It is also beneficial to note that travelers who pay tolls by means of E-pass are shown to be more likely to divert in the post-deployment model. This could be the result of increased high speed toll collection on OOCEA toll roads. Also, it should be noted that the travelers who were influenced by a DMS sign were more likely to divert. This is an encouraging result since this is the main function of the DMS, showing that they work.

APPENDIX A: IRB HUMAN SUBJECTS PERMISSION LETTERS

Approval of Pre-Deployment Survey 14 (Sample Size – 1000)

Revised 09/05

UCF IRB Addendum/Modification Request Form

This addendum form does NOT extend the IRB approval period or replace the Continuing Review form for renewal of the study.

INSTRUCTIONS: Please complete the upper portion of this form and attach all revised/new consent forms, altered data collection instruments, and/or any other documents that have been updated. **The proposed changes on the revised documents must be clearly indicated by using bold print, highlighting, or any other method of visible indication. Attach a highlighted and a clean copy of each revised form.** This Addendum/Modification Request Form may be emailed to IRB@mail.ucf.edu or mailed to the IRB Office: ATTN: IRB Coordinator, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or campus mail 32816-0150. Phone: 407-823-2901 or 407-882-2276, Fax: 407-823-3299.

- **DATE OF ADDENDUM:** _**October 26, 2006**_ to IRB# 3745 | IRB Addendum # 3943
- **PROJECT TITLE:** EVALUATING THE IMPACT OF OOCEA'S DYNAMIC MESSAGE SIGNS (DMS) ON TRAVELERS' EXPERIENCE
- **PRINCIPAL INVESTIGATOR:**

Haitham Al-Deek, Ph.D., P.E.
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http://www.catss.ucf.edu/tsi
- Employee ID: 0114408

- **MAILING ADDRESS: See above**
- **PHONE NUMBER & EMAIL ADDRESS: See above**
- **REASON FOR ADDENDUM/MODIFICATION: To modify pre-deployment survey instrument, minor but important changes are included with some additional questions.**
- **DESCRIPTION OF WHAT YOU WANT TO ADD OR MODIFY: Need approval of the revised survey instrument before the random digit dialing phone interview can be conducted. See revised survey.**

SECTION BELOW - FOR UCF IRB USE ONLY

X Approved ___ Disapproved

___ Full Board X Chair Expedited

Tracy Dietz
IRB Chair Signature — 10/27/06 Date

IRB Member/Designated Reviewer — Date

1

Approval of Pre-Deployment Survey 14A (Sample Size – 500)

Revised 09/05

UCF IRB Addendum/Modification Request Form

This addendum form does NOT extend the IRB approval period or replace the Continuing Review form for renewal of the study.

INSTRUCTIONS: Please complete the upper portion of this form and attach all revised/new consent forms, altered data collection instruments, and/or any other documents that have been updated. **The proposed changes on the revised documents must be clearly indicated by using bold print, highlighting, or any other method of visible indication. Attach a highlighted and a clean copy of each revised form.** This Addendum/Modification Request Form may be emailed to IRB@mail.ucf.edu or mailed to the IRB Office: ATTN: IRB Coordinator, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or campus mail 32816-0150. Phone: 407-823-2901 or 407-882-2276, Fax: 407-823-3299.

- **DATE OF ADDENDUM:** _**November 14, 2006**_ to IRB# 3745 IRB Addendum # 3944
- **PROJECT TITLE:** EVALUATING THE IMPACT OF OOCEA'S DYNAMIC MESSAGE SIGNS (DMS) ON TRAVELERS' EXPERIENCE
- **PRINCIPAL INVESTIGATOR:**

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- **MAILING ADDRESS: See above**
- **PHONE NUMBER & EMAIL ADDRESS: See above**
- **REASON FOR ADDENDUM/MODIFICATION: To modify pre-deployment survey instrument, minor but important changes are included with changes and sequence of some existing questions.**
- **DESCRIPTION OF WHAT YOU WANT TO ADD OR MODIFY: Need approval of the revised survey instrument before the random digit dialing phone interview can be conducted for and a new sample of 500 responses. See revised survey version 14.**

SECTION BELOW - FOR UCF IRB USE ONLY

_X_ Approved ____ Disapproved

____ Full Board _√_ Chair Expedited

IRB Chair Signature — Date 11/16/06

IRB Member/Designated Reviewer — Date

1

Approval of Pos-Deployment Survey 15 (Sample Size – 1500)

University of Central Florida

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901, 407-882-2012 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Notice of Expedited Review and Approval of Requested Addendum/Modification Changes

From: **UCF Institutional Review Board**
FWA00000351, Exp. 5/07/10, IRB00001138

To: **Haitham M. Al-Deek**

Date: **March 26, 2008**

IRB Number: **SBE-06-03745**

Study Title: **Evaluating the Impact of OOCEA's Dynamic Message Signs (DMS) on Travelers' Experience**

Dear Researcher:

Your requested addendum/modification changes to your study noted above which were submitted to the IRB on 03/25/2008 were approved by **expedited** review on 3/26/2008.

Per federal regulations, 45 CFR 46.110, the expeditable modifications were determined to be minor changes in previously approved research during the period for which approval was authorized.

<u>Use of the approved, stamped consent document(s) is required.</u> The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Subjects or their representatives must receive a copy of the consent form(s).

This addendum approval does NOT extend the IRB approval period or replace the Continuing Review form for renewal of the study.

On behalf of Tracy Dietz, Ph.D., IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 03/26/2008 02:48:17 PM EST

Joanne Muratori

IRB Coordinator

Internal IRB Submission Reference Number: 002641

APPENDIX B: PRE AND POST-DEPLOYMENT SURVEYS

Pre-Deployment Version 14 (Sample Size – 1000)

Survey (Survey Conductor should make the decision if the participant is Male or Female)

WE ARE CONDUCTING A SURVEY OF PEOPLE WHO USE THE ORLANDO-ORANGE COUNTY EXPRESSWAY AUTHORITY'S TOLL ROADS. WE ARE NOT SELLING YOU ANYTHING. WE ARE SIMPLY TRYING TO GET YOUR IMPRESSIONS ABOUT TRAVEL EXPERIENCES ON TOLL ROADS IN THE CENTRAL FLORIDA AREA AND MORE SPECIFICALLY ABOUT THE DYNAMIC MESSAGE SIGNS ON TOLL ROADS. YOUR RESPONSES ARE VERY IMPORTANT AS THEY WILL HELP US IMPROVE THE QUALITY OF TRAFFIC INFORMATION AND MAY LESSEN TRAFFIC CONGESTION ON THE TOLL ROADS. ALL ANSWERS ARE STRICTLY CONFIDENTIAL AND THE SURVEY WILL ONLY TAKE A FEW MINUTES OF YOUR TIME.

WOULD YOU LIKE TO PARTICIPATE IN THIS SURVEY?

Are you 18 years old or older? (Yes, No) (if "NO" terminate survey)

[Note to Survey Conductor: If asked about Dynamic Message Signs then read the introduction to Question 9 next page]

Survey Questions

1) In the past 6 months, did you travel on any of the following toll roads: State Road 408 (East-West Expressway), State Road 417 (Central Florida GreeneWay), State Road 429 (Western Expressway), or State Road 528 (Beach Line)?

a) Yes
b) No **(if "NO" terminate survey)**

2) Which of these toll roads do you travel on the most? (Only one selection)

a) State Road 408 (East-West Expressway)
b) State Road 417 (Central Florida GreeneWay)
c) State Road 429 (Western Expressway)
d) State Road 528 (Beach Line)

3) How many one-way trips do you make on your most traveled toll road?

a) Less than one a week
b) Between 1 to 5 trips a week
c) Between 6 to 10 trips a week
d) More than 10 trips a week

4) What is the main purpose of your most frequent trips on this toll road?

a) Work
b) Shopping
c) Recreational
d) School
e) Other

5) How many alternate routes to this toll road do you know?

a) None
b) 1 Route
c) 2 Routes
d) 3 Routes
e) 4 Routes or more

6) How do you pay tolls?

a) Cash
b) E-PASS or SUN-PASS

7) What type of vehicle do you travel in most of the time?

a) Motorcycle
b) Car/Light Truck/SUV
c) Semi-Truck
d) Commercial Truck or 18-wheeler

8) How do you acquire traffic information <u>while traveling</u> on the toll road, select all that apply?

a) Dynamic Message Signs
b) Radio Traffic Reports
c) 511 through Mobile Phone
d) Other
e) None

9) Do you agree or disagree that you are satisfied with traveler information provided on the toll roads?

a) Strongly Agree
b) Agree
c) Disagree
d) Strongly Disagree

10) A Dynamic Message Sign is an electronic traffic sign used on roadways to give travelers information about travel times, traffic congestion, accidents, disabled vehicles, AMBER ALERTS, or special events. The particular dynamic message signs referred to in this survey are large rectangular signs installed over the travel lanes. These are not the orange, portable trailer mounted signs you see on the side of the road during construction. For the purpose of this survey, please limit your comments to dynamic message signs on Central Florida toll roads only, not those found on local roads or interstate highways.

Do you recall seeing a Dynamic Message Sign during your travel on State Road 408 (East-West Expressway), State Road 417 (GreeneWay), State Road 429 (Western Expressway), State Road 528 (Beach Line)?

a) Yes
b) No **(if "NO" skip the yellow highlighted questions)**

11) Do you agree or disagree that Dynamic Message Signs improve your traveling experience on the toll roads?

a) Strongly Agree
b) Agree
c) Disagree
d) Strongly Disagree

12) Do you agree or disagree that Dynamic Message Signs have been helpful for giving you warnings on hazards on toll roads?

a) Strongly Agree
b) Agree
c) Disagree
d) Strongly Disagree

13) Do you agree or disagree that Dynamic Message Signs have been helpful for giving you special event information?

a) Strongly Agree
b) Agree
c) Disagree
d) Strongly Disagree

14) Do you agree or disagree that it is easy to read a Dynamic Message Sign while driving?

a) Strongly Agree
b) Agree
c) Disagree
d) Strongly Disagree

15) Do you agree or disagree that travel time information displayed on Dynamic Message Signs are accurate?

a) Strongly Agree
b) Agree
c) Disagree
d) Strongly Disagree

16) On Dynamic Message Signs what do you prefer?

a) Steady Message
b) Alternating Messages

17) On Dynamic Message Signs what style of message do you prefer to see in case of abnormal traffic conditions?

a) All Flashing Message
b) One Line Flashing Message
c) Non-Flashing Message

18) Within the past 6 months, did you ever become aware of unexpected congestion, due to an accident or a disabled vehicle, while traveling on any of the toll roads?

a) Yes **(if "YES" ask the green highlighted questions)**
b) No **(if "NO" ask the pink highlighted question)**

19) What was the cause of this unexpected congestion?

a) Accident
b) Disabled vehicle
c) Construction/road work
d) Weather Related
e) Other
f) Don't know

20) How did you first learn about the unexpected congestion? (Only Select One)

a) Dynamic Message Signs
b) Radio traffic reports
c) 511 Telephone
d) Direct observation of congestion
e) Other means

21) What did you do in response to the unexpected congestion? (Only Select One)

a) Stayed on the toll road and waited it out **(if the answer is “a” ask the blue highlighted question)**
b) Exited the toll road and got back on toll road at a different location
c) Exited the toll road and continued all the way to destination on an alternate route
d) Abandoned journey and returned to origin/home **(if the answer is “b, c, or d” ask the gray highlighted question next page)**

22) Suppose that you encounter a 30-minutes of unexpected congestion due to an accident or disabled vehicle on a toll road, what would you do? (Only Select One)

a) Stay on the toll road and wait it out **(if the answer is “a” ask the blue highlighted question)**
b) Exit the toll road and get back on toll road at a different location
c) Exit the toll road and continue all the way to destination on an alternate route
d) Abandon journey and return to origin/home **(if the answer is “b, c, or d” ask the gray highlighted question next page)**

23) What amount of unexpected delay would cause you to divert your route off the toll road?

a) up to 10 minutes
b) 10 to 20 minutes
c) 20 to 30 minutes
d) Over 30

24) What would be the main reason that you would stay on the toll road and wait it out? (Choose One Answer)

a) Unfamiliar with alternate routes
b) Do not trust accuracy of travel time information
c) It would still be faster to stay on toll road
d) Combination of any of the above
e) None of the above

25) If you received information from Dynamic Message Signs, would you say it helped you reschedule your travel by:

a) Adding unintended intermediate stops, e.g., to run errands
b) Canceling intended intermediate stop(s)
c) Informing someone that you are running late
d) Other
e) It did not help with rescheduling

26) By helping you select the most appropriate routes, Dynamic Message Signs have saved you time, do you:
   a) Strongly Agree
   b) Agree
   c) Disagree
   d) Strongly Disagree

27) Do you agree or disagree that I-Drive is a good abbreviation for International Drive?
   a) Strongly Agree
   b) Agree
   c) Disagree
   d) Strongly Disagree

28) Which do you prefer for identifying a roadway?
   a) State Road Number (for example State Road 50)
   b) Street Name (for example Colonial Drive)

29) Assume you are traveling on the toll roads and you see a Dynamic Message Sign displaying a travel time to a destination named "International Airport". How would you interpret the travel time given?
   a) The travel time is the amount of time it takes to get to the airport exit
   b) The travel time is the amount of time it takes to get to the airport terminal

30) Which of the following best describes your age?
   a) 18-25
   b) 26-35
   c) 36-50
   d) 51-65
   e) Over 65

31) What is your education level?
   a) High School Diploma or Less
   b) Some College
   c) Associate Degree
   d) Bachelor Degree
   e) Post Graduate Degree

32) What is your current zip code?

THANK YOU FOR PARTICIPATING IN THIS SURVEY!

END OF SURVEY

Pre-Deployment Version 14A (Sample Size – 500)

Survey (Survey Conductor should make the decision if the participant is Male or Female)

WE ARE CONDUCTING A SURVEY OF PEOPLE WHO USE THE ORLANDO-ORANGE COUNTY EXPRESSWAY AUTHORITY'S TOLL ROADS. WE ARE NOT SELLING YOU ANYTHING. WE ARE SIMPLY TRYING TO GET YOUR IMPRESSIONS ABOUT TRAVEL EXPERIENCES ON TOLL ROADS IN THE CENTRAL FLORIDA AREA AND MORE SPECIFICALLY ABOUT THE DYNAMIC MESSAGE SIGNS ON TOLL ROADS. YOUR RESPONSES ARE VERY IMPORTANT AS THEY WILL HELP US IMPROVE THE QUALITY OF TRAFFIC INFORMATION AND MAY LESSEN TRAFFIC CONGESTION ON THE TOLL ROADS. ALL ANSWERS ARE STRICTLY CONFIDENTIAL AND THE SURVEY WILL ONLY TAKE A FEW MINUTES OF YOUR TIME.

WOULD YOU LIKE TO PARTICIPATE IN THIS SURVEY?

Are you 18 years old or older? (Yes, No) (if “NO” terminate survey)

[Note to Survey Conductor: If asked about Dynamic Message Signs then read the introduction to Question 9 next page]

Survey Questions

1) In the past 6 months, did you travel on any of the following toll roads: State Road 408 (East-West Expressway), State Road 417 (Central Florida GreeneWay), State Road 429 (Western Expressway), or State Road 528 (Beach Line)?

a) Yes
b) No **(if “NO” terminate survey)**

2) Which of these toll roads do you travel on the most? (Only one selection)

a) State Road 408 (East-West Expressway)
b) State Road 417 (Central Florida GreeneWay)
c) State Road 429 (Western Expressway)
d) State Road 528 (Beach Line)

3) How many one-way trips do you make on your most traveled toll road?

a) Less than one a week
b) Between 1 to 5 trips a week
c) Between 6 to 10 trips a week
d) More than 10 trips a week

4) What is the main purpose of your most frequent trips on this toll road?

a) Work
b) Shopping
c) Recreational
d) School
e) Other

5) How many alternate routes to this toll road do you know?

a) None
b) 1 Route
c) 2 Routes
d) 3 Routes
e) 4 Routes or more

6) How do you pay tolls?

a) Cash
b) E-PASS or SUN-PASS

7) What type of vehicle do you travel in most of the time?

a) Motorcycle
b) Car/Light Truck/SUV
c) Semi-Truck
d) Commercial Truck or 18-wheeler

8) How do you acquire traffic information while traveling on the toll road, select all that apply?

a) Dynamic Message Signs
b) Radio Traffic Reports
c) 511 through Mobile Phone
d) Other
e) None

9) Do you agree or disagree that you are satisfied with traveler information provided on the toll roads?

a) Strongly Agree
b) Agree
c) Disagree
d) Strongly Disagree

10) A Dynamic Message Sign is an electronic traffic sign used on roadways to give travelers information about travel times, traffic congestion, accidents, disabled vehicles, AMBER ALERTS, or special events. The particular dynamic message signs referred to in this survey are large rectangular signs installed over the travel lanes. These are not the orange, portable trailer mounted signs you see on the side of the road during construction. For the purpose of this survey, please limit your comments to dynamic message signs on Central Florida toll roads only, not those found on local roads or interstate highways.

Do you recall seeing a Dynamic Message Sign during your travel on State Road 408 (East-West Expressway), State Road 417 (GreeneWay), State Road 429 (Western Expressway), State Road 528 (Beach Line)?

a) Yes
b) No **(if "NO" skip the yellow highlighted questions)**

11) Do you agree or disagree that Dynamic Message Signs improve your traveling experience on the toll roads?

a) Strongly Agree
b) Agree
c) Disagree
d) Strongly Disagree

12) Do you agree or disagree that Dynamic Message Signs have been helpful for giving you warnings on hazards on toll roads?

a) Strongly Agree
b) Agree
c) Disagree
d) Strongly Disagree

13) Do you agree or disagree that Dynamic Message Signs have been helpful for giving you special event information?

a) Strongly Agree
b) Agree
c) Disagree
d) Strongly Disagree

14) Do you agree or disagree that it is easy to read a Dynamic Message Sign while driving?

a) Strongly Agree
b) Agree
c) Disagree
d) Strongly Disagree

15) Do you agree or disagree that travel time information displayed on Dynamic Message Signs are accurate?

a) Strongly Agree
b) Agree
c) Disagree
d) Strongly Disagree

16) On Dynamic Message Signs what do you prefer?

a) Steady Message
b) Alternating Messages

17) On Dynamic Message Signs what style of message do you prefer to see in case of abnormal traffic conditions?

a) All Flashing Message
b) One Line Flashing Message
c) Non-Flashing Message

18) Within the past 6 months, did you ever become aware of unexpected congestion, due to an accident or a disabled vehicle, while traveling on any of the toll roads?

a) Yes **(if "YES" ask the green highlighted questions)**
b) No **(if "NO" ask the pink highlighted question 22, note that if the answer to question 22 is b, c, or d then question 24 should be skipped and NOT asked. Also, anytime the answer to questions 21 or 22 is b, c, or d then question 24 should not be skipped and NOT asked. Question 24 is intended only for those who answer "a" to questions 21 and/or 22 since it is meant to find out why travelers did not divert off (and stayed on) the toll road and wait it out?)**

19) What was the cause of this unexpected congestion?

a) Accident
b) Disabled vehicle
c) Construction/road work
d) Weather Related
e) Other
f) Don't know

20) How did you first learn about the unexpected congestion? (Only Select One)

a) Dynamic Message Signs
b) Radio traffic reports
c) 511 Telephone
d) Direct observation of congestion
e) Other means

23) How much time did you expect it to add to your trip?

a) up to 10 minutes
b) 10 to 20 minutes
c) 20 to 30 minutes
d) Over 30 minutes

21) What did you do in response to the unexpected congestion? (Only Select One)

a) Stayed on the toll road and waited it out **(if the answer is "a" ask the blue highlighted question, then after asking the blue highlighted question you need to go back and ask Question22 before you continue)**

b) Exited the toll road and got back on toll road at a different location

c) Exited the toll road and continued all the way to destination on an alternate route

d) Abandoned journey and returned to origin/home

22) Suppose that you encounter a 30-minutes of unexpected congestion due to an accident or disabled vehicle on a toll road, what would you do? (Only Select One)

a) Stay on the toll road and wait it out **(if the answer is "a" ask the blue highlighted question)**

b) Exit the toll road and get back on toll road at a different location

c) Exit the toll road and continue all the way to destination on an alternate route

d) Abandon journey and return to origin/home

24) What would be the main reason that you would stay on the toll road and wait it out? (Choose One Answer)

a) Unfamiliar with alternate routes

b) Do not trust accuracy of travel time information

c) It would still be faster to stay on toll road

d) Combination of any of the above

e) None of the above

(If the answer to Question 21 was (a), then you need to ask Question 24 and after you ask Question 24 you need to go back and ask Question 22 before you proceed to the next Question 25.

If the answer to Q 21 was (b) (c) or (d), ask Q 22. If Question 22 answer was (a) then you need to ask Question 24 and continue afterwards to the next Question 25). Note that Question 23 has been re-worded and moved to be before Question 21.

25) If you received information from Dynamic Message Signs, would you say it helped you reschedule your travel by:

a) Adding unintended intermediate stops, e.g., to run errands

b) Canceling intended intermediate stop(s)

c) Informing someone that you are running late

d) Other

e) It did not help with rescheduling

26) By helping you select the most appropriate routes, Dynamic Message Signs have saved you time, do you:
a) Strongly Agree
b) Agree
c) Disagree
d) Strongly Disagree

27) Do you agree or disagree that I-Drive is a good abbreviation for International Drive?
a) Strongly Agree
b) Agree
c) Disagree
d) Strongly Disagree

28) Which do you prefer for identifying a roadway?
a) State Road Number (for example State Road 50)
b) Street Name (for example Colonial Drive)

29) Assume you are traveling on the toll roads and you see a Dynamic Message Sign displaying a travel time to a destination named "International Airport". How would you interpret the travel time given?
a) The travel time is the amount of time it takes to get to the airport exit
b) The travel time is the amount of time it takes to get to the airport terminal

30) Which of the following best describes your age?
a) 18-25
b) 26-35
c) 36-50
d) 51-65
e) Over 65

31) What is your education level?
a) High School Diploma or Less
b) Some College
c) Associate Degree
d) Bachelor Degree
e) Post Graduate Degree

32) What is your current zip code?

THANK YOU FOR PARTICIPATING IN THIS SURVEY!

END OF SURVEY

Post-Deployment Version 15 (sample size – 1500)

WE ARE CONDUCTING A SURVEY OF PEOPLE WHO USE THE ORLANDO-ORANGE COUNTY EXPRESSWAY AUTHORITY'S TOLL ROADS. WE ARE NOT SELLING YOU ANYTHING. WE ARE SIMPLY TRYING TO GET YOUR IMPRESSIONS ABOUT TRAVEL EXPERIENCES ON TOLL ROADS IN THE CENTRAL FLORIDA AREA AND MORE SPECIFICALLY ABOUT THE DYNAMIC MESSAGE SIGNS ON TOLL ROADS. YOUR RESPONSES ARE VERY IMPORTANT AS THEY WILL HELP US IMPROVE THE QUALITY OF TRAFFIC INFORMATION AND MAY LESSEN TRAFFIC CONGESTION ON THE TOLL ROADS. ALL ANSWERS ARE STRICTLY CONFIDENTIAL AND THE SURVEY WILL ONLY TAKE A FEW MINUTES OF YOUR TIME.

WOULD YOU LIKE TO PARTICIPATE IN THIS SURVEY?

Are you 18 years old or older? (Yes, No) **(if “NO” terminate survey)**

[Note to Survey Conductor: If asked about Dynamic Message Signs then read the introduction to Question 12 next page]

The operator should first try to identify the participant’s gender by their voice, but if gender cannot be identified by the participant’s voice then ask the following question:

Would you mind disclosing your gender? (Male, Female)

<u>Survey Questions</u>

1) In the past 6 months, did you travel on any of the following toll roads: State Road 408 (East-West Expressway), State Road 417 (Central Florida GreeneWay), State Road 429 (Western Expressway), or State Road 528 (Beach Line)?

a) Yes
b) No **(if “NO” terminate survey)**

2) Which of these toll roads do you travel on the most? (Only one selection)

a) State Road 408 (East-West Expressway)
b) State Road 417 (Central Florida GreeneWay)
c) State Road 429 (Western Expressway)
d) State Road 528 (Beach Line)

3) How many one-way trips do you make on your most traveled toll road?

a) Less than one a week
b) Between 1 to 5 trips a week
c) Between 6 to 10 trips a week
d) More than 10 trips a week

4) What is the main purpose of your most frequent trips on this toll road?

a) Work
b) Shopping
c) Recreational
d) School
e) Other

5) Excluding intermediate stops, how long does your most frequent trip take on this toll road, from the origin to destination, one-way?

a) Below 15 minutes
b) 15 minutes to 30 minutes
c) 30 minutes to 45 minutes
d) 45 minutes to 60 minutes
e) Above 60 minutes

6) How many alternate routes to this toll road do you know?

a) None
b) 1 Route
c) 2 Routes
d) 3 Routes
e) 4 Routes or more

If the respondent answered question 6 as “a”, then do not ask question 7. If the respondent answered question 6 as “b, c, d, or e”, then ask question 7.

7) Excluding intermediate stops, how long does your best alternate route take from the origin to destination, one-way?

a) Below 15 minutes
b) 15 minutes to 30 minutes
c) 30 minutes to 45 minutes
d) 45 minutes to 60 minutes
e) Above 60 minutes

8) How do you pay tolls?

a) Cash
b) E-PASS or SUN-PASS

9) What type of vehicle do you travel in most of the time?

a) Motorcycle
b) Car/Light Truck/SUV
c) Semi-Truck or 18-wheeler

10) How do you acquire traffic information while traveling on the toll road, select all that apply?

a) Dynamic Message Signs
b) Radio Traffic Reports
c) 511 through Mobile Phone
d) Other
e) None

11) Do you agree or disagree that you are satisfied with traveler information provided on the toll roads?

a) Strongly Agree
b) Agree
c) Disagree
d) Strongly Disagree

12) A Dynamic Message Sign is an electronic traffic sign used on roadways to give travelers information about travel times, traffic congestion, accidents, disabled vehicles, AMBER ALERTS, or special events. The particular dynamic message signs referred to in this survey are large rectangular signs installed over the travel lanes. These are not the orange, portable trailer mounted signs you see on the side of the road during construction. For the purpose of this survey, please limit your comments to dynamic message signs on Central Florida toll roads only, not those found on local roads or interstate highways.

Do you recall seeing a Dynamic Message Sign during your travel on State Road 408 (East-West Expressway), State Road 417 (GreeneWay), State Road 429 (Western Expressway), State Road 528 (Beach Line)?

a) Yes
b) No **(if "NO" skip the yellow highlighted questions)**

13) Do you agree or disagree that Dynamic Message Signs improve your traveling experience on the toll roads?

a) Strongly Agree
b) Agree
c) Disagree
d) Strongly Disagree

14) Do you agree or disagree that Dynamic Message Signs have been helpful for giving you warnings on hazards on toll roads?

a) Strongly Agree
b) Agree
c) Disagree
d) Strongly Disagree

15) Do you agree or disagree that Dynamic Message Signs have been helpful for giving you special event information?

a) Strongly Agree
b) Agree
c) Disagree
d) Strongly Disagree

16) Do you agree or disagree that it is easy to read a Dynamic Message Sign while driving?

a) Strongly Agree
b) Agree
c) Disagree
d) Strongly Disagree

17) Do you agree or disagree that travel time information displayed on Dynamic Message Signs are accurate?

a) Strongly Agree
b) Agree
c) Disagree
d) Strongly Disagree

18) While traveling on OOCEA toll roads within the past 6 months, have you seen abnormal travel times displayed on Dynamic Message Signs (DMS), such as 20 minutes or more above the expected travel time displayed?

a) Yes
b) No (If no proceed to question 21)

19) Did you divert off of the toll road to avoid the abnormal travel time displayed on the Dynamic Message Sign (DMS)?

a) Yes
b) No **(if "NO" ask the bronze highlighted question)**

20) What would be the main reason that you would stay on the toll road? (Choose One Answer)

a) Unfamiliar with alternate routes
b) Do not trust accuracy of travel time information
c) Combination of a and b
d) None of the above

21) While traveling on OOCEA toll roads within the past 6 months, did you ever become aware of unexpected congestion, for example due to an accident or some other cause?

a) Yes (**if "YES" ask the green highlighted questions**)
b) No

22) What was the cause of this unexpected congestion?

a) Accident
b) Disabled vehicle
c) Construction/road work
d) Weather Related
e) Other
f) Don't know

If the respondent answered question 12 as "a", then ask question 23A. If the respondent answered question 12 as "b", then ask question 23B

23A) How did you first learn about the unexpected congestion? (Only Select One)

a) Dynamic Message Signs
b) Radio traffic reports
c) 511 Telephone
d) Direct observation of congestion
e) Other means

23B) How did you first learn about the unexpected congestion? (Only Select One)

b) Radio traffic reports
c) 511 Telephone
d) Direct observation of congestion
e) Other means

24) What toll road did you experience this unexpected congestion on?

a) State Road 408 (East-West Expressway)
b) State Road 417 (Central Florida GreeneWay)
c) State Road 429 (Western Expressway)
d) State Road 528 (Beach Line)

If the answer to 24 is "a" or "d", then you ask question 25A. If the answer to 24 is "b" or "c", then you ask question 25B.

25A) What direction were you traveling?

a) East-bound
b) West-bound

25B) What direction were you traveling?

a) North-bound
b) South-bound

26) How much time did you expect it to add to your trip?

a) up to 10 minutes
b) 10 to 20 minutes
c) 20 to 30 minutes
d) Over 30 minutes

27) On this particular trip during which time period did you travel?

a) Weekday morning rush hours
b) Weekday afternoon and evening rush hours
c) Non-rush hours and/or weekend

28) What did you do in response to the unexpected congestion? (Only Select One)

a) Stayed on the toll road and waited it out **(if the answer is "a" ask the blue highlighted question)**
b) Exited the toll road and got back on toll road at a different location
c) Exited the toll road and continued all the way to destination on an alternate route
d) Abandoned journey and returned to origin/home

If the respondent answered question 12 as "a", then ask question 29, and if the respondent answered question 12 as "b" then do not ask the respondent question 29.

29) Did a Dynamic Message Sign influence your reaction to the unexpected congestion?

a) Yes
b) No

30) What would be the main reason that you would stay on the toll road and wait it out? (Choose One Answer)

a) Unfamiliar with alternate routes
b) Do not trust accuracy of travel time information
c) It would still be faster to stay on toll road
d) Stuck between exits and not able to exit
e) Combination of any of the above
f) None of the above

31) Suppose that you encounter 30-minutes of unexpected congestion, for example due to an accident or some other cause, while traveling on any OOCEA toll roads on your most frequent trip, what would you do? (Only Select One)

a) Stay on the toll road and wait it out
b) Exit the toll road and get back on toll road at a different location
c) Exit the toll road and continue all the way to destination on an alternate route
d) Abandon journey and return to origin/home

32) If you received information from Dynamic Message Signs, would you say it helped reschedule your travel by:

a) Adding unintended intermediate stops, e.g., to run errands
b) Canceling intended intermediate stop(s)
c) Informing someone that you are running late
d) Other
e) It did not help with rescheduling

33) By helping you select the most appropriate routes, Dynamic Message Signs have saved you time, do you:

a) Strongly Agree
b) Agree
c) Disagree
d) Strongly Disagree

I am now going to give you a choice of names commonly associated with three roadways. Which of these would you prefer to see on a Dynamic Message Sign to identify the roadway?

34) Would you prefer:

a) State Road 436, or
b) Semoran Boulevard

35) Would you prefer:

a) State Road 426, or
b) Aloma Avenue

36) Would you prefer:

a) State Road 434, or
b) Alafaya Trail

37) If there was an abnormal traffic situation, such as an accident or unexpected congestion, on any of the OOCEA toll roads, would you like a Dynamic Message Sign to inform you of this situation?

a) Yes
b) No

If the respondent answered question 37 as “a”, then ask question 38, and if the respondent answered question 37 as “b” then do not ask the respondent question 38

38) How would you like the Dynamic Message Sign to inform you of this abnormal traffic situation?

a) Steady Message
b) Flashing Message
c) Two page message describing the traffic situation and the travel time
d) Flashing beacon on top of Dynamic Message Sign

39) Which of the following best describes your age?

a) 18-25
b) 26-35
c) 36-50
d) 51-65
e) Over 65

40) What is your education level?

a) High School Diploma or Less
b) Some College
c) Associate Degree
d) Bachelor Degree
e) Post Graduate Degree

41) How long have you resided in the Central Florida Area?

a) Less than 6 months
b) Between 6 to 12 months
c) Between 1 to 5 years
d) Between 5 to 10 years
e) More than 10 years

THANK YOU FOR PARTICIPATING IN THIS SURVEY!

END OF SURVEY

APPENDIX C: RESULTS OF PRE-DEPLOYMENT SURVEY (1500 RESPONSES)

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q2	most used toll road	A) SR 408	524	34.9%		A) SR 408
		B) SR 417	723	48.2%	B) SR 417	
		C) SR 429	91	6.1%		
		D) SR 528	162	10.8%		
		ALL q2	1500	100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q3	number trip a week	A) <1 trip a week	558	37.2%		A) <1 trip a week
		B) 1-5 trips a week	597	39.8%	B) 1-5 trips a week	
		C) 6-10 trips a week	192	12.8%		
		D) >10 trips a week	153	10.2%		
		ALL q3	1500	100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q4	trip purpose	A) Work	607	40.5%	A) Work	
		B) Shopping	196	13.1%		
		C) Recreational	260	17.3%		
		D) School	40	2.7%		
		E) Other	397	26.5%		E) Other
		ALL q4	1500	100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q5	number of known alternate routes	A) None	160	10.7%		
		B) 1 Route	271	18.1%		
		C) 2 Routes	423	28.2%	C) 2 Routes	
		D) 3 Routes	244	16.3%		
		E) 4 Routes or more	402	26.8%		E) 4 Routes or more
		ALL q5	1500	100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1
Q6	payment method	A) Cash	537	35.8%	
		B) E-PASS or SUN-PASS	963	64.2%	B) E-PASS or SUN-PASS
		ALL q6	1500	100.0%	

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q7	vehicle type	A) Motorcycle	6	0.4%		
		B) Car/Light Truck/SUV	1451	96.7%	B) Car/Light Truck/SUV	
		C) Semi-Truck	12	0.8%		
		D) Commercial Truck or 18-wheeler	31	2.1%		D) Commercial Truck or 18-wheeler
		All q7	1500	100.0%		

#	Question Summary	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q8(Totaled)	traffic info used	A) Dynamic Message Signs	408	23.9%		A) Dynamic Message Signs
		B) Radio Traffic Reports	697	40.8%	B) Radio Traffic Reports	
		C) 511 through Mobile Phone	96	5.6%		
		D) Other	224	13.1%		
		E) None	283	16.6%		
		ALL q8R(TotaledDMS)	1708	100.0%		

#	Question Summary	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q9	satisfaction traveler information	A) Strongly Agree	324	21.6%		A) Strongly Agree
		B) Agree	873	58.2%	B) Agree	
		C) Disagree	204	13.6%		
		D) Strongly Disagree	99	6.6%		
		ALL q9	1500	100.0%		

#	Question Summary	*variable*	Frequency	Percent (%)	Mode 1
Q10	recall seeing DMS on toll road	A) Yes	816	54.4%	A) Yes
		B) No	684	45.6%	
		ALL q10	1500	100.0%	

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q11	DMS improve travel experience	A) Strongly Agree	341	41.8%	22.7%		A) Strongly Agree
		B) Agree	353	43.3%	23.5%	B) Agree	
		C) Disagree	90	11.0%	6.0%		
		D) Strongly Disagree	32	3.9%	2.1%		
		ALL Answered q11	816	100.0%	54.4%		
		ALL Unanswered q11	684		45.6%		
		ALL q11	1500		100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q12	DMS helpful informing about hazards	A) Strongly Agree	374	45.8%	24.9%	A) Strongly Agree	
		B) Agree	364	44.6%	24.3%		B) Agree
		C) Disagree	57	7.0%	3.8%		
		D) Strongly Disagree	21	2.6%	1.4%		
		ALL Answered q12	816	100.0%	54.4%		
		ALL Unanswered q12	684		45.6%		
		ALL q12	1500		100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q13	DMS helpful giving special event information	A) Strongly Agree	229	28.1%	15.3%		A) Strongly Agree
		B) Agree	333	40.8%	22.2%	B) Agree	
		C) Disagree	200	24.5%	13.3%		
		D) Strongly Disagree	54	6.6%	3.6%		
		ALL Answered q13	816	100.0%	54.4%		
		ALL Unanswered q13	684		45.6%		
		ALL q13	1500		100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q14	easy to read DMS while driving	A) Strongly Agree	352	43.1%	23.5%		A) Strongly Agree
		B) Agree	391	47.9%	26.1%	B) Agree	
		C) Disagree	50	6.1%	3.3%		
		D) Strongly Disagree	23	2.8%	1.5%		
		ALL Answered q14	816	100.0%	54.4%		
		ALL Unanswered q14	684		45.6%		
		ALL q14	1500		100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q15	travel time on DMS accurate	A) Strongly Agree	226	27.7%	15.1%		A) Strongly Agree
		B) Agree	459	56.3%	30.6%	B) Agree	
		C) Disagree	103	12.6%	6.9%		
		D) Strongly Disagree	28	3.4%	1.9%		
		ALL Answered q15	816	100.0%	54.4%		
		ALL Unanswered q15	684		45.6%		
		ALL q15	1500		100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q16	on DMS what is preferred	A) Steady Message	518	63.5%	34.5%	A) Steady Message	
		B) Alternating Message	298	36.5%	19.9%		B) Alternating Message
		ALL Answered q16	816	100.0%	54.4%		
		ALL Unanswered q16	684		45.6%		
		ALL q16	1500		100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q17	style message on DMS preferred abnormal conditions	A) All Flashing Message	256	31.4%	17.1%		A) All Flashing Message
		B) One Line Flashing Message	212	26.0%	14.1%		
		C) Non-Flashing Message	348	42.6%	23.2%	C) Non-Flashing Message	
		ALL Answered q17	816	100.0%	54.4%		
		ALL Unanswered q17	684		45.6%		
		ALL q17	1500		100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q18	last 6 months ever aware on unexpected congestion on toll road	A) Yes	736	49.1%		A) Yes
		B) No	764	50.9%	B) No	
		ALL q18	1500	100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q19	the cause of unexpected congestion	A) Accident	476	64.7%	31.7%	A) Accident	
		B) Disabled vehicle	22	3.0%	1.5%		
		C) Construction/road work	142	19.3%	9.5%		C) Construction/road work
		D) Weather Related	11	1.5%	0.7%		
		E) Other	51	6.9%	3.4%		
		F) Don't know	34	4.6%	2.3%		
		All Answered q19	736	100.0%	49.1%		
		All Unanswered q19	764		50.9%		
		All q19	1500		100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q20	how first learned of unexpected congestion	A) Dynamic Message Signs	205	27.9%	13.7%		A) Dynamic Message Signs
		B) Radio Traffic Reports	104	14.1%	6.9%		
		C) 511 Telephone	8	1.1%	0.5%		
		D) Direct observation of congestion	385	52.3%	25.7%	D) Direct observation of congestion	
		E) Other means	34	4.6%	2.3%		
		ALL Answered q20	736	100.0%	49.1%		
		ALL Unanswered q20	764		50.9%		
		ALL q20	1500		100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q21	response to unexpected congestion	A) Stayed on toll road	445	60.5%	29.7%	A) Stayed on toll road	
		B) Exited toll road and got back on	54	7.3%	3.6%		
		C) Exited toll road and continued on alternate route	222	30.2%	14.8%		C) Exited toll road and continued on alternate route
		D) Abandoned journey	15	2.0%	1.0%		
		ALL Answered q21	736	100.0%	49.1%		
		ALL Unanswered q21	764		50.9%		
		ALL q21	1500		100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q21	response to unexpected congestion	A) Stayed on toll road	160	62.7%	32.0%	A) Stayed on toll road	
		B) Exited toll road and got back on	17	6.7%	3.4%		
		C) Exited toll road and continued on alternate route	72	28.2%	14.4%		C) Exited toll road and continued on alternate route
		D) Abandoned journey	6	2.4%	1.2%		
		ALL Answered q21	255	100.0%	51.0%		
		ALL Unanswered q21	245		49.0%		
		ALL q21	500		100.0%		

**The above table is from the question in the 500-sample survey, and are values that were used for modeling revealed preference diversion.*

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q22	suppose 30 minutes of unexpected congestion	A) Stayed on toll road	268	26.3%	17.9%		A) Stayed on toll road
		B) Exited toll road and got back on	236	23.2%	15.7%		
		C) Exited toll road and continued on alternate route	486	47.7%	32.4%	C) Exited toll road and continued on alternate route	
		D) Abandoned journey	29	2.8%	1.9%		
		ALL Answered q22	1019	100.0%	67.9%		
		ALL Unanswered q22	481		32.1%		
		ALL q22	1500		100.0%		

#	**Question Summary**	<u>*variable*</u>	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q23	amount of unexpected delay that would cause you to divert	A) up to 10 minutes	194	22.9%	12.9%		A) up to 10 minutes
		<u>B) 10 to 20 minutes</u>	<u>314</u>	<u>37.0%</u>	<u>20.9%</u>	<u>B) 10 to 20 minutes</u>	
		C) 20 to 30 minutes	193	22.7%	12.9%		
		D) Over 30 minutes	148	17.4%	9.9%		
		ALL Answered q23	849	100.0%	56.6%		
		ALL Unanswered q23	651		43.4%		
		ALL q23	1500		100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q23A	how much time did you expect it to add to your trip?	A) up to 10 minutes	66	25.9%	13.2%		A) up to 10 minutes
		B) 10 to 20 minutes	94	36.9%	18.8%	B) 10 to 20 minutes	
		C) 20 to 30 minutes	46	18.0%	9.2%		
		D) Over 30 minutes	49	19.2%	9.8%		
		ALL Answered q23	255	100.0%	51.0%		
		ALL Unanswered q23	245		49.0%		
		ALL q23	500		100.0%		

**The above table 23A was asked in the 500 survey only to those who were asked question 21.*

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q24	main reason to stay on the toll road and wait it out	A) Unfamiliar with alternate routes	139	21.4%	9.3%		
		B) Do not trust travel time information	8	1.2%	0.5%		
		C) It would be faster to stay on the toll road	230	35.4%	15.3%	C) It would be faster to stay on the toll road	
		D) Combination of any of the above	162	24.9%	10.8%		D) Combination of any of the above
		E) None of the above	111	17.1%	7.4%		
		ALL Answered q24	650	100.0%	43.3%		
		ALL Unanswered q24	850		56.7%		
		ALL q24	1500		100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q25	DMS helped reschedule travel by:	A) Adding unintended intermediate stops	57	7.0%	3.8%		
		B) Canceling intended intermediate stops	25	3.1%	1.7%		
		C) Informing someone that you are running late	469	57.5%	31.3%	C) Informing someone that you are running late	
		D) Other	80	9.8%	5.3%		
		E) It did not help with rescheduling	185	22.7%	12.3%		E) It did not help with rescheduling
		ALL Answered q25	816	100.0%	54.4%		
		ALL Unanswered q25	684		45.6%		
		ALL q25	1500		100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q26	DMS have helped you save time	A) Strongly Agree	224	27.5%	14.9%		A) Strongly Agree
		B) Agree	415	50.9%	27.7%	B) Agree	
		C) Disagree	128	15.7%	8.5%		
		D) Strongly Disagree	49	6.0%	3.3%		
		ALL Answered q26	816	100.0%	54.4%		
		ALL Unanswered q26	684		45.6%		
		ALL q26	1500		100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q27	I-Drive good abbreviation for International Drive	A) Strongly Agree	586	39.1%		A) Strongly Agree
		B) Agree	673	44.9%	B) Agree	
		C) Disagree	153	10.2%		
		D) Strongly Disagree	88	5.9%		
		ALL q27	1500	100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q28	prefer for identifying a roadway	A) State Road Number	821	54.7%	A) State Road Number	
		B) Street Name	679	45.3%		B) Street Name
		ALL q28	1500	100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q29	interpretation of travel time to International Airport	A) airport exit	813	54.2%	A) airport exit	
		B) airport terminal	687	45.8%		B) airport terminal
		ALL q29	1500	100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q30	age range	A) 18-25	75	5.0%		
		B) 26-35	214	14.3%		
		C) 36-50	595	39.7%	C) 36-50	
		D) 51-65	421	28.1%		D) 51-65
		E) Over 65	195	13.0%		
		ALL q30	1500	100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q31	educational level	A) High School Diploma or Less	267	17.8%		
		B) Some College	362	24.1%		B) Some College
		C) Associate Degree	148	9.9%		
		D) Bachelor Degree	471	31.4%	D) Bachelor Degree	
		E) Post Graduate Degree	252	16.8%		
		ALL q31	1500	100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
County	county	ORANGE	519	34.6%	ORANGE	
		OSCEOLA	480	32.0%		
		SEMINOLE	501	33.4%		SEMINOLE
		ALL county	1500	100.0%		

APPENDIX D: RESULTS OF POST-DEPLOYMENT SURVEY (1500 RESPONSES)

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q2	most used toll road	A) SR 408	452	30.1%		A) SR 408
		B) SR 417	796	53.1%	B) SR 417	
		C) SR 429	103	6.9%		
		D) SR 528	149	9.9%		
		ALL q2	1500	100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q3	number trip a week	A) <1 trip a week	591	39.4%		A) <1 trip a week
		B) 1-5 trips a week	638	42.5%	B) 1-5 trips a week	
		C) 6-10 trips a week	162	10.8%		
		D) >10 trips a week	109	7.3%		
		ALL q3	1500	100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q4	trip purpose	A) Work	491	32.7%	A) Work	
		B) Shopping	192	12.8%		
		C) Recreational	286	19.1%		
		D) School	48	3.2%		
		E) Other	483	32.2%		E) Other
		ALL q4	1500	100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q5	travel time on most frequently traveled toll road	A) Below 15 minutes	205	13.7%		
		B) 15 minutes to 30 minutes	803	53.5%	B) 15 minutes to 30 minutes	
		C) 30 minutes to 45 minutes	356	23.7%		C) 30 minutes to 45 minutes
		D) 45 minutes to 60 minutes	81	5.4%		
		E) Above 60 minutes	55	3.7%		
		ALL q5	1500	100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q6	number of known alternate routes	A) None	162	10.8%		
		B) 1 Route	278	18.5%		
		C) 2 Routes	425	28.3%	C) 2 Routes	
		D) 3 Routes	260	17.4%		
		E) 4 Routes or more	375	25.0%		E) 4 Routes or more
		ALL q5	1500	100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q7	travel time on alternate route	A) Below 15 minutes	113	7.5%		
		B) 15 minutes to 30 minutes	484	32.3%	B) 15 minutes to 30 minutes	
		C) 30 minutes to 45 minutes	429	28.6%		C) 30 minutes to 45 minutes
		D) 45 minutes to 60 minutes	190	12.7%		
		E) Above 60 minutes	122	8.1%		
		ALL unanswered q7	162	10.8%		
		ALL q7	1500	100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1
Q8	payment method	A) Cash	446	29.7%	
		B) E-PASS or SUN-PASS	1054	70.3%	B) E-PASS or SUN-PASS
		ALL q6	1500	100.0%	

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q9	vehicle type	A) Motorcycle	4	0.33%		
		B) Car/Light Truck/SUV	1477	98.5%	B) Car/Light Truck/SUV	
		C) Semi-Truck or 18-wheeler	19	1.27%		C) Semi-Truck or 18-wheeler
		All q7	1500	100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q10(Totaled)	traffic info used	A) Dynamic Message Signs	409	24.2%		A) Dynamic Message Signs
		B) Radio Traffic Reports	580	34.3%	B) Radio Traffic Reports	
		C) 511 through Mobile Phone	102	6.0%		
		D) Other	207	12.3%		
		E) None	392	23.2%		
		ALL q8R(TotaledDMS)	1690	100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q11	satisfaction traveler information	A) Strongly Agree	268	17.9%		A) Strongly Agree
		B) Agree	996	66.4%	B) Agree	
		C) Disagree	173	11.5%		
		D) Strongly Disagree	63	4.2%		
		ALL q9	1500	100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1
Q12	recall seeing DMS on toll road	A) Yes	959	63.9%	A) Yes
		B) No	541	36.1%	
		ALL q10	1500	100.0%	

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q13	DMS improve travel experience	A) Strongly Agree	300	31.3%	20.0%		A) Strongly Agree
		B) Agree	525	54.7%	35.0%	B) Agree	
		C) Disagree	105	10.9%	7.0%		
		D) Strongly Disagree	29	3.1%	1.9%		
		ALL Answered q11	959	100.0%	63.9%		
		ALL Unanswered q11	541		36.1%		
		ALL q11	1500		100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q14	DMS helpful informing about hazards	A) Strongly Agree	333	34.7%	22.2%		A) Strongly Agree
		B) Agree	528	55.1%	35.2%	B) Agree	
		C) Disagree	77	8.0%	5.1%		
		D) Strongly Disagree	21	2.2%	1.4%		
		ALL Answered q12	959	100.0%	63.9%		
		ALL Unanswered q12	541		36.1%		
		ALL q12	1500		100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q15	DMS helpful giving special event information	A) Strongly Agree	211	22.0%	14.1%		A) Strongly Agree
		B) Agree	503	52.5%	33.5%	B) Agree	
		C) Disagree	199	20.8%	13.3%		
		D) Strongly Disagree	46	4.8%	3.1%		
		ALL Answered q13	959	100.0%	63.9%		
		ALL Unanswered q13	541		36.1%		
		ALL q13	1500		100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q16	easy to read DMS while driving	A) Strongly Agree	342	35.7%	22.8%		A) Strongly Agree
		B) Agree	540	56.3%	36.0%	B) Agree	
		C) Disagree	53	5.5%	3.5%		
		D) Strongly Disagree	24	2.5%	1.6%		
		ALL Answered q14	959	100.0%	63.9%		
		ALL Unanswered q14	541		36.1%		
		ALL q14	1500		100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q17	travel time on DMS accurate	A) Strongly Agree	220	22.9%	14.7%		A) Strongly Agree
		B) Agree	618	64.4%	41.2%	B) Agree	
		C) Disagree	96	10.0%	6.4%		
		D) Strongly Disagree	25	2.6%	1.7%		
		ALL Answered q15	959	100.0%	63.9%		
		ALL Unanswered q15	541		36.1%		
		ALL q15	1500		100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1
Q18	have you seen abnormal travel times	A) Yes	409	27.3%	
		B) No	550	36.7%	B) No
		ALL Unanswered q18	541	36.1%	
		ALL q18	1500	100.0%	

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1
Q19	did you divert due to abnormal travel times	A) Yes	201	13.4%	
		B) No	208	13.9%	B) No
		ALL Unanswered q19	1091	72.7%	
		ALL q19	1500	100.0%	

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q20	Main reason you would stay on toll road	A) Unfamiliar with alternate routes	36	2.4%		
		B) Do not trust accuracy of travel time information	17	1.1%		
		C) Combination of A and B	51	3.4%		C) Combination of A and B
		D) None of the Above	104	6.9%	D) None of the Above	
		ALL Unanswered q20	1292	86.1%		
		ALL q20	1500	63.5%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q21	last 6 months ever aware on unexpected congestion on toll road	A) Yes	732	48.8%		A) Yes
		B) No	768	51.2%	B) No	
		ALL q18	1500	100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q22	the cause of unexpected congestion	A) Accident	452	61.7%	30.1%	A) Accident	
		B) Disabled vehicle	32	4.4%	2.1%		
		C) Construction/road work	140	19.1%	9.3%		C) Construction/road work
		D) Weather Related	8	1.1%	0.5%		
		E) Other	68	9.3%	4.5%		
		F) Don't know	32	4.4%	2.1%		
		All Answered q19	732	100.0%	48.8%		
		All Unanswered q19	768		51.2%		
		All q19	1500		100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q23A	how first learned of unexpected congestion	A) Dynamic Message Signs	185	34.0%	12.3%		A) Dynamic Message Signs
		B) Radio Traffic Reports	58	10.7%	3.9%		
		C) 511 Telephone	5	0.9%	0.3%		
		D) Direct observation of congestion	268	49.3%	17.9%	D) Direct observation of congestion	
		E) Other means	28	5.1%	1.9%		
		ALL Answered q20	544	100.0%	36.27%		
		ALL Unanswered q20	956		63.73%		
		ALL q20	1500		100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q23B	how first learned of unexpected congestion	B) Radio Traffic Reports	21	11.1%	1.4%		B) Radio Traffic Reports
		C) 511 Telephone	6	3.2%	0.4%		
		D) Direct observation of congestion	143	75.3%	9.5%	D) Direct observation of congestion	
		E) Other means	20	10.5%	1.3%		
		ALL Answered q20	190	100.0%	12.67%		
		ALL Unanswered q20	1310		87.33%		
		ALL q20	1500		100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q24	What toll road did you experience congestion	A) SR 408	354	48.36%	23.6%	A) SR 408	
		B) SR 417	234	32.0%	15.6%		B) SR 417
		C) SR 429	18	2.4%	1.2%		
		D) SR 528	126	17.2%	8.4%		
		ALL Answered q24	732	100.0%	48.8%		
		ALL Unanswered q24	768		51.2%		
		ALL q24	1500		100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1
Q25A	What direction were you traveling	A) East-Bound	236	15.7%	
		B) West-Bound	245	16.3%	B) West-Bound
		ALL unanswered q25A	1019	68.0%	
		ALL q25A	1500	100.0%	

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1
Q25B	What direction were you traveling	A) North-Bound	143	9.5%	A) North-Bound
		B) South-Bound	110	7.3%	
		ALL unanswered q25B	1247	83.2%	
		ALL q18	1500	100.0%	

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q26	How much time did it add to your trip	A) up to 10 minutes	279	18.6%	A) up to 10 minutes	
		B) 10 to 20 minutes	239	15.9%		B) 10 to 20 minutes
		C) 20 to 30 minutes	115	7.7%		
		D) Over 30 minutes	99	6.6%		
		ALL unanswered q26	768	51.2%		
		ALL q18	1500	100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q27	Which time period were you traveling	A) Weekday morning rush	187	12.5%		
		B) Weekday afternoon and evening rush	265	17.7%		B) Weekday afternoon and evening rush
		C) Non-rush / weekend	280	18.7%	C) Non-rush / weekend	
		ALL unanswered q27	768	51.2%		
		ALL q18	1500	100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q28	response to unexpected congestion	A) Stayed on toll road	525	71.7%	35.0%	A) Stayed on toll road	
		B) Exited toll road and got back on	41	5.6%	2.7%		
		C) Exited toll road and continued on alternate route	151	20.6%	10.1%		C) Exited toll road and continued on alternate route
		D) Abandoned journey	15	2.1%	1.0%		
		ALL Answered q21	732	100.0%	48.8%		
		ALL Unanswered q21	768		51.2%		
		ALL q21	1500		100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1
Q29	Did a DMS influence your decision	A) Yes	230	15.3%	
		B) No	313	20.9%	B) No
		ALL unanswered q29	957	63.8%	
		ALL q29	1500	100.0%	

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q30	main reason to stay on the toll road and wait it out	A) Unfamiliar with alternate routes	73	13.9%	4.9%		
		B) Do not trust travel time information	3	0.6%	0.2%		
		C) It would be faster to stay on the toll road	142	27.0%	9.5%	C) It would be faster to stay on the toll road	
		D) Stuck between exits and not able to exit	131	24.9%	8.7%		D) Stuck between exits and not able to exit
		D) Combination of any of the above	116	22.1%	7.7%		
		E) None of the above	60	11.4%	4.0%		
		ALL Answered q24	525	100.0%	35.0%		
		ALL Unanswered q24	975		65.0%		
		ALL q24	1500		100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q31	suppose 30 minutes of unexpected congestion	A) Stayed on toll road	399	26.6%		A) Stayed on toll road
		B) Exited toll road and got back on	278	18.5%		
		C) Exited toll road and continued on alternate route	783	52.2%	C) Exited toll road and continued on alternate route	
		D) Abandoned journey	40	2.7%		
		ALL q22	1500	100%		

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q32	DMS helped reschedule travel by:	A) Adding unintended intermediate stops	41	4.3%	2.7%		
		B) Canceling intended intermediate stops	28	2.9%	1.9%		
		C) Informing someone that you are running late	511	53.3%	34.1%	C) Informing someone that you are running late	
		D) Other	142	14.8%	9.5%		
		E) It did not help with rescheduling	273	28.5%	18.2%		E) It did not help with rescheduling
		ALL Answered q25	959	100.0%	63.9%		
		ALL Unanswered q25	541		36.1%		
		ALL q25	1500		100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%) (not including unanswered)	Percent (%) (including unanswered)	Mode 1	Mode 2
Q33	DMS have helped you save time	A) Strongly Agree	180	18.8%	12.0%		A) Strongly Agree
		B) Agree	545	56.8%	36.3%	B) Agree	
		C) Disagree	191	19.9%	12.7%		
		D) Strongly Disagree	43	4.5%	2.9%		
		ALL Answered q26	959	100.0%	63.9%		
		ALL Unanswered q26	541		36.1%		
		ALL q26	1500		100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1
Q34	What would you prefer	A) SR 436	638	42.5%	
		B) Semoran Blvd	321	21.4%	B) No
		ALL unanswered q34	541	36.1%	
		ALL q34	1500	100.0%	

#	**Question Summary**	*Variable*	Frequency	Percent (%)	Mode 1
Q35	What would you prefer	A) SR 426	355	23.7%	
		B) Aloma Ave	604	40.3%	B) No
		ALL unanswered q35	541	36.1%	
		ALL q35	1500	100.0%	

#	**Question Summary**	*Variable*	Frequency	Percent (%)	Mode 1
Q36	What would you prefer	A) SR 434	484	32.3%	
		B) Alafaya Trail	475	31.7%	B) No
		ALL unanswered q36	541	36.1%	
		ALL q36	1500	100.0%	

#	**Question Summary**	*Variable*	Frequency	Percent (%)	Mode 1
Q37	Would you like to be informed of abnormal traffic situation	A) Yes	901	60.1%	
		B) No	58	3.9%	B) No
		ALL unanswered q37	541	36.1%	
		ALL q37	1500	100.0%	

#	**Question Summary**	*Variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q38	How would you like the DMS to inform of abnormal traffic situation	A) Steady Message	269	17.9%		A) Steady Message
		B) Flashing Message	361	24.1%	B) Flashing Message	
		C) Two page message	154	10.3%		
		D) Flashing beacon	117	7.8%		
		ALL unanswered q38	541	36.1%		
		ALL q38	1500	100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q39	age range	A) 18-25	49	3.3%		
		B) 26-35	119	7.9%		
		C) 36-50	455	30.3%		C) 36-50
		D) 51-65	524	34.9%	D) 51-65	
		E) Over 65	325	21.7%		
		ALL q30	1500	100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q40	educational level	A) High School Diploma or Less	283	18.9%		
		B) Some College	289	19.3%		B) Some College
		C) Associate Degree	150	10.0%		
		D) Bachelor Degree	464	30.9%	D) Bachelor Degree	
		E) Post Graduate Degree	255	17.0%		
		ALL q31	1500	100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
Q40	Residency in Central Florida	A) Less than 6 months	16	18.9%		
		B) Between 6 to 12 months	13	19.3%		
		C) Between 1 to 5 years	173	10.0%		
		D) Between 5 to 10 years	203	30.9%		D) Between 5 to 10 years
		E) More than 10 years	1059	17.00%	E) More than 10 years	
		ALL q31	1500	100.0%		

#	**Question Summary**	*variable*	Frequency	Percent (%)	Mode 1	Mode 2
county	county	ORANGE	500	33.33%		
		OSCEOLA	500	33.33%		
		SEMINOLE	500	33.33%		
		ALL county	1500	100.0%		

APPENDIX E: DATA SET-UP LOGIT MODELING SAMPLE

Respondent #	county (Orange)	county (Osceola)	county (Seminole)	Q28 (Divert)	q26 (Ordinal expected delay)
1007	0	0	1	0	35
1008	1	0	0	0	15
1010	1	0	0	1	35
1014	1	0	0	1	15
1015	0	0	1	0	5
1017	1	0	0	1	15
1021	0	0	1	0	5
1022	0	1	0	1	25
1023	0	1	0	0	5
1024	0	1	0	0	35
1026	0	0	1	1	25
1027	1	0	0	0	15
1030	0	1	0	0	15
1034	0	1	0	0	25
1036	0	1	0	0	35
1037	1	0	0	0	5
1038	1	0	0	1	35
1039	0	1	0	0	35
1041	0	1	0	0	25
1042	1	0	0	1	25
1044	0	1	0	0	5
1045	0	0	1	0	35
1048	0	1	0	0	5
1049	0	1	0	0	25
1053	0	1	0	0	15
1054	0	1	0	0	15
1055	1	0	0	1	5
1057	0	0	1	1	35
1059	0	0	1	0	15
1061	0	0	1	0	15
1066	0	1	0	1	15

APPENDIX F: LIMDEP/NLOGIT FINAL MODELING OUTPUTS

Model Output for Pre-Deployment Satisfaction Comparison

```
Normal exit from iterations. Exit status=0.

+---------------------------------------------+
| Multinomial Logit Model                     |
| Maximum Likelihood Estimates                |
| Model estimated: Jul 01, 2008 at 11:00:58AM.|
| Dependent variable            SATISFAC      |
| Weighting variable                None      |
| Number of observations             816      |
| Iterations completed                 6      |
| Log likelihood function      -276.5221      |
| Restricted log likelihood    -356.1727      |
| Chi squared                   159.3010      |
| Degrees of freedom                   9      |
| Prob[ChiSqd > value] =        .0000000      |
| Hosmer-Lemeshow chi-squared =   9.26918     |
| P-value=  .32010 with deg.fr. =      8      |
+---------------------------------------------+
+---------+--------------+----------------+--------+---------+----------+
|Variable | Coefficient  | Standard Error |b/St.Er.|P[|Z|>z] | Mean of X|
+---------+--------------+----------------+--------+---------+----------+
         Characteristics in numerator of Prob[Y = 1]
 Constant    -1.43368349      .34269812    -4.184   .0000
 Q3_A          .47561078      .26830116     1.773   .0763     .35539216
 Q4_WS        -.35812765      .24008641    -1.492   .1358     .42892157
 Q5_C          .65676440      .28196935     2.329   .0198     .28308824
 Q8_A          .46172139      .27510076     1.678   .0933     .30514706
 Q12_AB       1.47074813      .36124885     4.071   .0000     .90441176
 Q13_AB        .27572080      .24409764     1.130   .2587     .72671569
 Q15_AB       1.62006807      .25060736     6.465   .0000     .83946078
 Q25_B       -1.03543856      .53863635    -1.922   .0546     .03063725
 Q26_AB        .37179248      .26732049     1.391   .1643     .78308824


+---------------------------------------------------------------------+
| Information Statistics for Discrete Choice Model.                   |
|                           M=Model MC=Constants Only   M0=No Model   |
| Criterion F (log L)     -276.52214       -356.17265    -565.60810   |
| LR Statistic vs. MC      159.30102           .00000        .00000   |
| Degrees of Freedom         9.00000           .00000        .00000   |
| Prob. Value for LR          .00000           .00000        .00000   |
| Entropy for probs.       276.52214        356.17265     565.60810   |
| Normalized Entropy          .48889           .62972       1.00000   |
| Entropy Ratio Stat.      578.17191        418.87089        .00000   |
| Bayes Info Criterion     613.38401        772.68504    1191.55593   |
| BIC - BIC(no model)      578.17191        418.87089        .00000   |
| Pseudo R-squared            .22363           .00000        .00000   |
| Pct. Correct Prec.        86.76471           .00000      50.00000   |
| Means:        y=0    y=1    y=2    y=3    yu=4   y=5,    y=6   y>=7  |
| Outcome      .1581  .8419  .0000  .0000  .0000  .0000  .0000  .0000 |
| Pred.Pr      .1581  .8419  .0000  .0000  .0000  .0000  .0000  .0000 |
| Notes: Entropy computed as Sum(i)Sum(j)Pfit(i,j)*logPfit(i,j).      |
|        Normalized entropy is computed against M0.                   |
|        Entropy ratio statistic is computed against M0.              |
|        BIC = 2*criterion - log(N)*degrees of freedom.               |
|        If the model has only constants or if it has no constants,   |
|        the statistics reported here are not useable.                |
+---------------------------------------------------------------------+
```

```
+----------------------------------------+
| Fit Measures for Binomial Choice Model |
| Logit    model for variable SATISFAC   |
+----------------------------------------+
| Proportions P0= .158088   P1= .841912  |
| N =     816 N0=     129   N1=     687  |
| LogL =  -276.52214 LogL0 =  -356.1727  |
| Estrella = 1-(L/L0)^(-2L0/n) = .19826  |
+----------------------------------------+
|     Efron |  McFadden  |  Ben./Lerman  |
|    .23599 |    .22363  |       .79786  |
|    Cramer | Veall/Zim. |     Rsqrd_ML  |
|    .24064 |    .35044  |       .17735  |
+----------------------------------------+
| Information  Akaike I.C. Schwarz I.C.  |
| Criteria         .70226    620.08843   |
+----------------------------------------+
Frequencies of actual & predicted outcomes
Predicted outcome has maximum probability.
Threshold value for predicting Y=1 = .5000
            Predicted
------  ----------  +  -----
Actual      0    1  |  Total
------  ----------  +  -----
  0        38   91  |    129
  1        17  670  |    687
------  ----------  +  -----
Total      55  761  |    816

=======================================================================
Analysis of Binary Choice Model Predictions Based on Threshold =  .5000
-----------------------------------------------------------------------
Prediction Success
-----------------------------------------------------------------------
Sensitivity = actual 1s correctly predicted                   97.525%
Specificity = actual 0s correctly predicted                   29.457%
Positive predictive value = predicted 1s that were actual 1s  88.042%
Negative predictive value = predicted 0s that were actual 0s  69.091%
Correct prediction = actual 1s and 0s correctly predicted     86.765%
-----------------------------------------------------------------------
Prediction Failure
-----------------------------------------------------------------------
False pos. for true neg. = actual 0s predicted as 1s          70.543%
False neg. for true pos. = actual 1s predicted as 0s           2.475%
False pos. for predicted pos. = predicted 1s actual 0s        11.958%
False neg. for predicted neg. = predicted 0s actual 1s        30.909%
False predictions = actual 1s and 0s incorrectly predicted    13.235%
=======================================================================
```

Model Output for Post-Deployment Satisfaction Comparison

```
Normal exit from iterations. Exit status=0.

+---------------------------------------------+
| Multinomial Logit Model                     |
| Maximum Likelihood Estimates                |
| Model estimated: Jul 01, 2008 at 11:04:59AM.|
| Dependent variable             SATISFAC     |
| Weighting variable                 None     |
| Number of observations              959     |
| Iterations completed                  6     |
| Log likelihood function       -345.2663     |
| Restricted log likelihood     -407.3674     |
| Chi squared                    124.2022     |
| Degrees of freedom                    9     |
| Prob[ChiSqd > value] =         .0000000     |
| Hosmer-Lemeshow chi-squared =   3.45576     |
| P-value=  .90260 with deg.fr. =       8     |
+---------------------------------------------+
+---------+--------------+----------------+--------+---------+----------+
|Variable | Coefficient  | Standard Error |b/St.Er.|P[|Z|>z] | Mean of X|
+---------+--------------+----------------+--------+---------+----------+
          Characteristics in numerator of Prob[Y = 1]
 Constant      -.57531454      .31700240    -1.815   .0695
 Q3_A           .81062536      .26299999     3.082   .0021     .31386861
 Q4_WS         -.64004030      .20944385    -3.056   .0022     .42544317
 Q6_C           .28727346      .22998981     1.249   .2116     .27007299
 Q10_A          .12035562      .22533111      .534   .5933     .30448384
 Q14_AB        1.03212470      .27516948     3.751   .0002     .89781022
 Q15_AB         .72003433      .22128610     3.254   .0011     .74452555
 Q17_AB         .77212152      .25318635     3.050   .0023     .87382690
 Q32_B         -.98178888      .45960761    -2.136   .0327     .02919708
 Q33_AB         .54458105      .22692370     2.400   .0164     .75599583


+--------------------------------------------------------------------+
| Information Statistics for Discrete Choice Model.                  |
|                           M=Model MC=Constants Only   M0=No Model  |
| Criterion F (log L)     -345.26629        -407.36741    -664.72815 |
| LR Statistic vs. MC      124.20224            .00000        .00000 |
| Degrees of Freedom         9.00000            .00000        .00000 |
| Prob. Value for LR          .00000            .00000        .00000 |
| Entropy for probs.       345.26629         407.36741     664.72815 |
| Normalized Entropy          .51941            .61283       1.00000 |
| Entropy Ratio Stat.      638.92371         514.72147        .00000 |
| Bayes Info Criterion     752.32560         876.52784    1391.24931 |
| BIC - BIC(no model)      638.92371         514.72147        .00000 |
| Pseudo R-squared            .15244            .00000        .00000 |
| Pct. Correct Prec.        86.86131            .00000      50.00000 |
| Means:       y=0    y=1    y=2    y=3    yu=4   y=5,    y=6   y>=7 |
| Outcome     .1512  .8488  .0000  .0000  .0000  .0000  .0000  .0000 |
| Pred.Pr     .1512  .8488  .0000  .0000  .0000  .0000  .0000  .0000 |
| Notes: Entropy computed as Sum(i)Sum(j)Pfit(i,j)*logPfit(i,j).     |
|        Normalized entropy is computed against M0.                  |
|        Entropy ratio statistic is computed against M0.             |
|        BIC = 2*criterion - log(N)*degrees of freedom.              |
|        If the model has only constants or if it has no constants,  |
|        the statistics reported here are not useable.               |
+--------------------------------------------------------------------+
```

```
+---------------------------------------------+
| Fit Measures for Binomial Choice Model |
| Logit    model for variable SATISFAC    |
+---------------------------------------------+
| Proportions P0= .151199   P1= .848801   |
| N =      959 N0=     145   N1=     814   |
| LogL =  -345.26629 LogL0 =  -407.3674   |
| Estrella = 1-(L/L0)^(-2L0/n) = .13109   |
+---------------------------------------------+
|     Efron |  McFadden  |  Ben./Lerman   |
|    .16130 |    .15244  |       .78399   |
|    Cramer | Veall/Zim. |      Rsqrd_ML   |
|    .15842 |    .24963  |       .12148   |
+---------------------------------------------+
| Information  Akaike I.C. Schwarz I.C.   |
| Criteria         .74091     759.19150   |
+---------------------------------------------+
Frequencies of actual & predicted outcomes
Predicted outcome has maximum probability.
Threshold value for predicting Y=1 = .5000
            Predicted
------  ----------  +  -----
Actual      0    1  |  Total
------  ----------  +  -----
  0        29  116  |    145
  1        10  804  |    814
------  ----------  +  -----
Total      39  920  |    959

=======================================================================
Analysis of Binary Choice Model Predictions Based on Threshold =  .5000
-----------------------------------------------------------------------
Prediction Success
-----------------------------------------------------------------------
Sensitivity = actual 1s correctly predicted                   98.771%
Specificity = actual 0s correctly predicted                   20.000%
Positive predictive value = predicted 1s that were actual 1s  87.391%
Negative predictive value = predicted 0s that were actual 0s  74.359%
Correct prediction = actual 1s and 0s correctly predicted     86.861%
-----------------------------------------------------------------------
Prediction Failure
-----------------------------------------------------------------------
False pos. for true neg. = actual 0s predicted as 1s          80.000%
False neg. for true pos. = actual 1s predicted as 0s           1.229%
False pos. for predicted pos. = predicted 1s actual 0s        12.609%
False neg. for predicted neg. = predicted 0s actual 1s        25.641%
False predictions = actual 1s and 0s incorrectly predicted    13.139%
=======================================================================
```

Model Output for Diversion Table 34

```
Normal exit from iterations. Exit status=0.

+---------------------------------------------+
| Multinomial Logit Model                     |
| Maximum Likelihood Estimates                |
| Model estimated: Jul 03, 2008 at 04:34:35PM.|
| Dependent variable             Q28_DIVE     |
| Weighting variable                 None     |
| Number of observations              672     |
| Iterations completed                  5     |
| Log likelihood function       -381.3341     |
| Restricted log likelihood     -406.5279     |
| Chi squared                    50.38767     |
| Degrees of freedom                    8     |
| Prob[ChiSqd > value] =         .0000000     |
| Hosmer-Lemeshow chi-squared =   7.59921     |
| P-value=  .47357 with deg.fr. =       8     |
+---------------------------------------------+
+---------+--------------+----------------+--------+---------+----------+
|Variable | Coefficient  | Standard Error |b/St.Er.|P[|Z|>z] | Mean of X|
+---------+--------------+----------------+--------+---------+----------+
          Characteristics in numerator of Prob[Y = 1]
 Constant    -2.03096389      .36434666    -5.574   .0000
 Q5_ORDIN     -.01706348      .00832413    -2.050   .0404    28.0357143
 Q7_ORD2       .00084777      .00672005      .126   .8996    35.1339286
 Q10_1         .01179173      .20096870      .059   .9532      .30208333
 Q10_2         .18357393      .18851363      .974   .3302      .42857143
 Q10_3         .46402777      .30655489     1.514   .1301      .08035714
 Q10_4        -.18803350      .27508543     -.684   .4943      .14583333
 Q26_ORD2     .04457746      .00856333     5.206   .0000    15.3571429
 Q6_ORDIN      .28780105      .07995786     3.599   .0003    2.60267857
+----------------------------------------------------------------------+
| Information Statistics for Discrete Choice Model.                    |
|                            M=Model MC=Constants Only   M0=No Model |
| Criterion F (log L)     -381.33411        -406.52794    -465.79491 |
| LR Statistic vs. MC       50.38767            .00000        .00000 |
| Degrees of Freedom         8.00000            .00000        .00000 |
| Prob. Value for LR          .00000            .00000        .00000 |
| Entropy for probs.       381.33411         406.52794     465.79491 |
| Normalized Entropy          .81867            .87276       1.00000 |
| Entropy Ratio Stat.      168.92160         118.53393        .00000 |
| Bayes Info Criterion     814.75028         865.13794     983.67188 |
| BIC - BIC(no model)      168.92160         118.53393        .00000 |
| Pseudo R-squared            .06197            .00000        .00000 |
| Pct. Correct Prec.        71.87500            .00000      50.00000 |
| Means:       y=0    y=1    y=2    y=3    yu=4   y=5,    y=6   y>=7 |
| Outcome     .7068  .2932  .0000  .0000  .0000  .0000  .0000  .0000 |
| Pred.Pr     .7068  .2932  .0000  .0000  .0000  .0000  .0000  .0000 |
| Notes: Entropy computed as Sum(i)Sum(j)Pfit(i,j)*logPfit(i,j).      |
|        Normalized entropy is computed against M0.                    |
|        Entropy ratio statistic is computed against M0.               |
|        BIC = 2*criterion - log(N)*degrees of freedom.                |
|        If the model has only constants or if it has no constants,   |
|        the statistics reported here are not useable.                 |
+----------------------------------------------------------------------+
```

```
+---------------------------------------------+
| Fit Measures for Binomial Choice Model |
| Logit    model for variable Q28_DIVE   |
+---------------------------------------------+
| Proportions P0= .706845   P1= .293155  |
| N =     672 N0=     475   N1=     197  |
| LogL =  -381.33411 LogL0 =  -406.5279  |
| Estrella = 1-(L/L0)^(-2L0/n) = .07449  |
+---------------------------------------------+
|     Efron |  McFadden  |  Ben./Lerman  |
|    .07165 |    .06197  |       .61599  |
|    Cramer | Veall/Zim. |     Rsqrd_ML  |
|    .07341 |    .12740  |       .07224  |
+---------------------------------------------+
| Information  Akaike I.C. Schwarz I.C.  |
| Criteria        1.16171    821.26054  |
+---------------------------------------------+
Frequencies of actual & predicted outcomes
Predicted outcome has maximum probability.
Threshold value for predicting Y=1 = .5000
            Predicted
------  ----------  +  -----
Actual      0    1  |  Total
------  ----------  +  -----
  0       455   20  |    475
  1       169   28  |    197
------  ----------  +  -----
Total     624   48  |    672

=======================================================================
Analysis of Binary Choice Model Predictions Based on Threshold =  .5000
-----------------------------------------------------------------------
Prediction Success
-----------------------------------------------------------------------
Sensitivity = actual 1s correctly predicted                    14.213%
Specificity = actual 0s correctly predicted                    95.789%
Positive predictive value = predicted 1s that were actual 1s  58.333%
Negative predictive value = predicted 0s that were actual 0s  72.917%
Correct prediction = actual 1s and 0s correctly predicted     71.875%
-----------------------------------------------------------------------
Prediction Failure
-----------------------------------------------------------------------
False pos. for true neg. = actual 0s predicted as 1s           4.211%
False neg. for true pos. = actual 1s predicted as 0s          85.787%
False pos. for predicted pos. = predicted 1s actual 0s        41.667%
False neg. for predicted neg. = predicted 0s actual 1s        27.083%
False predictions = actual 1s and 0s incorrectly predicted    28.125%
```

Model Output for Diversion Table 35

```
Normal exit from iterations. Exit status=0.
+---------------------------------------------+
| Multinomial Logit Model                     |
| Maximum Likelihood Estimates                |
| Model estimated: Jul 03, 2008 at 04:37:03PM.|
| Dependent variable              Q28_DIVE    |
| Weighting variable                  None    |
| Number of observations               672    |
| Iterations completed                   6    |
| Log likelihood function        -328.1423    |
| Restricted log likelihood      -406.5279    |
| Chi squared                     156.7713    |
| Degrees of freedom                    18    |
| Prob[ChiSqd > value] =          .0000000    |
| Hosmer-Lemeshow chi-squared =    6.84603    |
| P-value=  .55333 with deg.fr. =        8    |
+---------------------------------------------+
+-------+--------------+----------------+--------+---------+----------+
|Variable|Coefficient  | Standard Error |b/St.Er.|P[|Z|>z] | Mean of X|
+-------+--------------+----------------+--------+---------+----------+
          Characteristics in numerator of Prob[Y = 1]
 Constant    -4.29019503      .64670733    -6.634   .0000
 Q39_2         .97297157      .34780523     2.797   .0052     .07589286
 Q2_1          .89086701      .31593694     2.820   .0048     .33035714
 Q2_2          .68258203      .30163841     2.263   .0236     .51339286
 Q3_4          .46190365      .30221442     1.528   .1264     .10565476
 Q5_ORDIN    -.01939491      .00931189    -2.083   .0373    28.0357143
 Q7_ORD2       .00481174      .00762603      .631   .5281    35.1339286
 Q6_ORDIN      .23408321      .08818588     2.654   .0079    2.60267857
 Q8_1          .66616727      .22497219     2.961   .0031     .24553571
 Q10_1       -.11095692      .22516283     -.493   .6222     .30208333
 Q10_2         .18130408      .21039249      .862   .3888     .42857143
 Q10_3         .73570882      .34082928     2.159   .0309     .08035714
 Q10_4       -.21347521      .31545331     -.677   .4986     .14583333
 Q19_L1        .58990798      .23379868     2.523   .0116     .20535714
 Q22_A_C_    -.58257861      .32887891    -1.771   .0765     .91071429
 Q26_ORD2      .04679548      .00975380     4.798   .0000    15.3571429
 Q27_1         .41260752      .21882473     1.886   .0594     .25744048
 Q29_L1        .71244852      .20580257     3.462   .0005     .31845238
 Q31_DIVE     1.68465213      .29025727     5.804   .0000     .73660714
+--------------------------------------------------------------------+
| Information Statistics for Discrete Choice Model.                  |
|                           M=Model MC=Constants Only   M0=No Model |
| Criterion F (log L)     -328.14227       -406.52794    -465.79491 |
| LR Statistic vs. MC      156.77134           .00000        .00000 |
| Degrees of Freedom        18.00000           .00000        .00000 |
| Prob. Value for LR          .00000           .00000        .00000 |
| Entropy for probs.       328.14227        406.52794     465.79491 |
| Normalized Entropy          .70448           .87276       1.00000 |
| Entropy Ratio Stat.      275.30527        118.53393        .00000 |
| Bayes Info Criterion     773.46919        930.24053    1048.77446 |
| BIC - BIC(no model)      275.30527        118.53393        .00000 |
| Pseudo R-squared            .19282           .00000        .00000 |
| Pct. Correct Prec.        76.19048           .00000      50.00000 |
| Means:        y=0    y=1    y=2    y=3    yu=4   y=5,    y=6   y>=7 |
| Outcome     .7068  .2932  .0000  .0000  .0000  .0000  .0000  .0000 |
| Pred.Pr     .7068  .2932  .0000  .0000  .0000  .0000  .0000  .0000 |
| Notes: Entropy computed as Sum(i)Sum(j)Pfit(i,j)*logPfit(i,j).     |
|        Normalized entropy is computed against M0.                  |
|        Entropy ratio statistic is computed against M0.             |
```

```
|        BIC = 2*criterion - log(N)*degrees of freedom.                |
|        If the model has only constants or if it has no constants,    |
|        the statistics reported here are not useable.                 |
+----------------------------------------------------------------------+
+-----------------------------------------+
| Fit Measures for Binomial Choice Model |
| Logit    model for variable Q28_DIVE   |
+-----------------------------------------+
| Proportions P0= .706845   P1= .293155  |
| N =     672 N0=     475   N1=     197  |
| LogL =  -328.14227 LogL0 =  -406.5279  |
| Estrella = 1-(L/L0)^(-2L0/n) = .22831  |
+-----------------------------------------+
|     Efron |  McFadden  |  Ben./Lerman  |
|    .22507 |    .19282  |       .67820  |
|    Cramer | Veall/Zim. |     Rsqrd_ML  |
|    .22352 |    .34551  |       .20808  |
+-----------------------------------------+
| Information  Akaike I.C. Schwarz I.C.  |
| Criteria        1.03316    779.97945   |
+-----------------------------------------+
Frequencies of actual & predicted outcomes
Predicted outcome has maximum probability.
Threshold value for predicting Y=1 = .5000
            Predicted
------  ----------  +  -----
Actual      0    1  |  Total
------  ----------  +  -----
  0       436   39  |    475
  1       121   76  |    197
------  ----------  +  -----
Total     557  115  |    672

=======================================================================
Analysis of Binary Choice Model Predictions Based on Threshold =  .5000
-----------------------------------------------------------------------
Prediction Success
-----------------------------------------------------------------------
Sensitivity = actual 1s correctly predicted                   38.579%
Specificity = actual 0s correctly predicted                   91.789%
Positive predictive value = predicted 1s that were actual 1s  66.087%
Negative predictive value = predicted 0s that were actual 0s  78.276%
Correct prediction = actual 1s and 0s correctly predicted     76.190%
-----------------------------------------------------------------------
Prediction Failure
-----------------------------------------------------------------------
False pos. for true neg. = actual 0s predicted as 1s           8.211%
False neg. for true pos. = actual 1s predicted as 0s          61.421%
False pos. for predicted pos. = predicted 1s actual 0s        33.913%
False neg. for predicted neg. = predicted 0s actual 1s        21.724%
False predictions = actual 1s and 0s incorrectly predicted    23.810%
=======================================================================
```

Model Output for Diversion Table 36 (Post)

```
+---------------------------------------------+
| Multinomial Logit Model                     |
| Maximum Likelihood Estimates                |
| Model estimated: Jul 03, 2008 at 04:43:01PM.|
| Dependent variable            Q28_DIVE      |
| Weighting variable                None      |
| Number of observations             672      |
| Iterations completed                 6      |
| Log likelihood function      -349.9724      |
| Restricted log likelihood    -406.5279      |
| Chi squared                   113.1110      |
| Degrees of freedom                  12      |
| Prob[ChiSqd > value] =        .0000000      |
| Hosmer-Lemeshow chi-squared =   6.70968     |
| P-value=  .56825 with deg.fr. =      8      |
+---------------------------------------------+
+-------+-------------+--------------+--------+---------+----------+
|Variable| Coefficient | Standard Error |b/St.Er.|P[|Z|>z] | Mean of X|
+-------+-------------+--------------+--------+---------+----------+
         Characteristics in numerator of Prob[Y = 1]
 Constant    -3.58579780      .53916476    -6.651   .0000
 Q2_1          .84527364      .30121061     2.806   .0050     .33035714
 Q2_2          .58145122      .28893854     2.012   .0442     .51339286
 Q5_ORDIN     -.01747971      .00884632    -1.976   .0482    28.0357143
 Q6_ORDIN      .26449909      .08424335     3.140   .0017    2.60267857
 Q7_ORD2       .00323306      .00721145      .448   .6539    35.1339286
 Q8_2         -.65956814      .21327760    -3.093   .0020     .75446429
 Q10_1      -.325845D-04      .21301165      .000   .9999     .30208333
 Q10_2         .24445629      .20098736     1.216   .2239     .42857143
 Q10_3         .78794082      .32875541     2.397   .0165     .08035714
 Q10_4        -.14590345      .29692792     -.491   .6232     .14583333
 Q26_ORD2      .04686622      .00914481     5.125   .0000    15.3571429
 Q31_DIVE     1.66669048      .27889512     5.976   .0000     .73660714
+----------------------------------------------------------------------+
| Information Statistics for Discrete Choice Model.                    |
|                             M=Model MC=Constants Only   M0=No Model |
| Criterion F (log L)      -349.97244       -406.52794    -465.79491 |
| LR Statistic vs. MC       113.11100           .00000        .00000 |
| Degrees of Freedom         12.00000           .00000        .00000 |
| Prob. Value for LR           .00000           .00000        .00000 |
| Entropy for probs.        349.97244        406.52794     465.79491 |
| Normalized Entropy           .75134           .87276       1.00000 |
| Entropy Ratio Stat.       231.64493        118.53393        .00000 |
| Bayes Info Criterion      778.06798        891.17898    1009.71291 |
| BIC - BIC(no model)       231.64493        118.53393        .00000 |
| Pseudo R-squared             .13912           .00000        .00000 |
| Pct. Correct Prec.         73.80952           .00000      50.00000 |
| Means:        y=0    y=1    y=2    y=3    yu=4   y=5,    y=6   y>=7 |
| Outcome      .7068  .2932  .0000  .0000  .0000  .0000  .0000  .0000 |
| Pred.Pr      .7068  .2932  .0000  .0000  .0000  .0000  .0000  .0000 |
| Notes: Entropy computed as Sum(i)Sum(j)Pfit(i,j)*logPfit(i,j).      |
|        Normalized entropy is computed against M0.                   |
|        Entropy ratio statistic is computed against M0.              |
|        BIC = 2*criterion - log(N)*degrees of freedom.               |
|        If the model has only constants or if it has no constants,   |
|        the statistics reported here are not useable.                |
+----------------------------------------------------------------------+
```

```
+---------------------------------------------+
| Fit Measures for Binomial Choice Model |
| Logit    model for variable Q28_DIVE   |
+---------------------------------------------+
| Proportions P0= .706845   P1= .293155  |
| N =     672 N0=     475   N1=     197  |
| LogL =  -349.97244 LogL0 =  -406.5279  |
| Estrella = 1-(L/L0)^(-2L0/n) = .16577  |
+---------------------------------------------+
|     Efron |  McFadden  |  Ben./Lerman  |
|    .15801 |    .13912  |        .65123 |
|    Cramer | Veall/Zim. |      Rsqrd_ML |
|    .15845 |    .26315  |        .15492 |
+---------------------------------------------+
| Information  Akaike I.C. Schwarz I.C.  |
| Criteria       1.08028     784.57823  |
+---------------------------------------------+
Frequencies of actual & predicted outcomes
Predicted outcome has maximum probability.
Threshold value for predicting Y=1 = .5000
            Predicted
------  ----------  +  -----
Actual      0    1  |  Total
------  ----------  +  -----
  0       439   36  |    475
  1       140   57  |    197
------  ----------  +  -----
Total     579   93  |    672

=======================================================================
Analysis of Binary Choice Model Predictions Based on Threshold =  .5000
-----------------------------------------------------------------------
Prediction Success
-----------------------------------------------------------------------
Sensitivity = actual 1s correctly predicted                    28.934%
Specificity = actual 0s correctly predicted                    92.421%
Positive predictive value = predicted 1s that were actual 1s  61.290%
Negative predictive value = predicted 0s that were actual 0s  75.820%
Correct prediction = actual 1s and 0s correctly predicted      73.810%
-----------------------------------------------------------------------
Prediction Failure
-----------------------------------------------------------------------
False pos. for true neg. = actual 0s predicted as 1s            7.579%
False neg. for true pos. = actual 1s predicted as 0s           71.066%
False pos. for predicted pos. = predicted 1s actual 0s         38.710%
False neg. for predicted neg. = predicted 0s actual 1s         24.180%
False predictions = actual 1s and 0s incorrectly predicted     26.190%
=======================================================================
```

Model Output for Diversion Table 36 (Pre)

```
Normal exit from iterations. Exit status=0.
+---------------------------------------------+
| Multinomial Logit Model                     |
| Maximum Likelihood Estimates                |
| Model estimated: Jul 03, 2008 at 04:45:38PM.|
| Dependent variable            Q21_DIVE      |
| Weighting variable                None      |
| Number of observations             232      |
| Iterations completed                 5      |
| Log likelihood function      -135.7542      |
| Restricted log likelihood    -153.4827      |
| Chi squared                   35.45688      |
| Degrees of freedom                  10      |
| Prob[ChiSqd > value] =        .1043150E-03 |
| Hosmer-Lemeshow chi-squared =   6.01253     |
| P-value=  .64583 with deg.fr. =       8     |
+---------------------------------------------+
+--------+-------------+---------------+--------+---------+----------+
|Variable|Coefficient  | Standard Error |b/St.Er.|P[|Z|>z] | Mean of X|
+--------+-------------+---------------+--------+---------+----------+
          Characteristics in numerator of Prob[Y = 1]
 Constant    -3.50838005      .79629712    -4.406   .0000
 Q2ASR4        .88541683      .46685611     1.897   .0579     .38362069
 Q2BSR4        .24507308      .45782481      .535   .5924     .46551724
 Q5ORDIN       .00656026      .13198543      .050   .9604    2.65086207
 Q6PAYME       .42166429      .33735912     1.250   .2113     .68965517
 Q8ADMS        .17611290      .35430047      .497   .6191     .28879310
 Q8BRADI       .66139796      .33271470     1.988   .0468     .54310345
 Q8C511        .92323549      .61231505     1.508   .1316     .06034483
 Q8DOTHE       .69716430      .43475834     1.604   .1088     .15948276
 Q23AORD       .03232204      .01466810     2.204   .0276    18.2758621
 Q22_DIVE     1.34051718      .38630691     3.470   .0005     .71982759
+--------------------------------------------------------------------+
| Information Statistics for Discrete Choice Model.                  |
|                           M=Model MC=Constants Only   M0=No Model |
| Criterion F (log L)     -135.75423       -153.48267    -160.81015 |
| LR Statistic vs. MC       35.45688           .00000        .00000 |
| Degrees of Freedom        10.00000           .00000        .00000 |
| Prob. Value for LR          .00010           .00000        .00000 |
| Entropy for probs.       135.75423        153.48267     160.81015 |
| Normalized Entropy          .84419           .95443       1.00000 |
| Entropy Ratio Stat.       50.11183         14.65495        .00000 |
| Bayes Info Criterion     325.97584        361.43272     376.08767 |
| BIC - BIC(no model)       50.11183         14.65495        .00000 |
| Pseudo R-squared            .11551           .00000        .00000 |
| Pct. Correct Prec.        68.10345           .00000      50.00000 |
| Means:        y=0    y=1    y=2    y=3    yu=4   y=5,    y=6   y>=7 |
| Outcome     .6250  .3750  .0000  .0000  .0000  .0000  .0000  .0000 |
| Pred.Pr     .6250  .3750  .0000  .0000  .0000  .0000  .0000  .0000 |
| Notes: Entropy computed as Sum(i)Sum(j)Pfit(i,j)*logPfit(i,j).     |
|        Normalized entropy is computed against M0.                  |
|        Entropy ratio statistic is computed against M0.             |
|        BIC = 2*criterion - log(N)*degrees of freedom.              |
|        If the model has only constants or if it has no constants,  |
|        the statistics reported here are not useable.               |
+--------------------------------------------------------------------+
```

```
+---------------------------------------------+
| Fit Measures for Binomial Choice Model |
| Logit    model for variable Q21_DIVE   |
+---------------------------------------------+
| Proportions P0= .625000   P1= .375000  |
| N =     232 N0=     145   N1=      87  |
| LogL =  -135.75423 LogL0 =  -153.4827  |
| Estrella = 1-(L/L0)^(-2L0/n) = .14990  |
+---------------------------------------------+
|     Efron |  McFadden  |  Ben./Lerman  |
|    .14504 |    .11551  |       .59880  |
|    Cramer | Veall/Zim. |     Rsqrd_ML  |
|    .14411 |    .23277  |       .14173  |
+---------------------------------------------+
| Information  Akaike I.C. Schwarz I.C.  |
| Criteria       1.26512     331.42258  |
+---------------------------------------------+
Frequencies of actual & predicted outcomes
Predicted outcome has maximum probability.
Threshold value for predicting Y=1 = .5000
            Predicted
------  ----------  +  -----
Actual      0    1  |  Total
------  ----------  +  -----
  0       123   22  |    145
  1        52   35  |     87
------  ----------  +  -----
Total     175   57  |    232

=======================================================================
Analysis of Binary Choice Model Predictions Based on Threshold =  .5000
-----------------------------------------------------------------------
Prediction Success
-----------------------------------------------------------------------
Sensitivity = actual 1s correctly predicted                   40.230%
Specificity = actual 0s correctly predicted                   84.828%
Positive predictive value = predicted 1s that were actual 1s  61.404%
Negative predictive value = predicted 0s that were actual 0s  70.286%
Correct prediction = actual 1s and 0s correctly predicted     68.103%
-----------------------------------------------------------------------
Prediction Failure
-----------------------------------------------------------------------
False pos. for true neg. = actual 0s predicted as 1s          15.172%
False neg. for true pos. = actual 1s predicted as 0s          59.770%
False pos. for predicted pos. = predicted 1s actual 0s        38.596%
False neg. for predicted neg. = predicted 0s actual 1s        29.714%
False predictions = actual 1s and 0s incorrectly predicted    31.897%
=======================================================================
```

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